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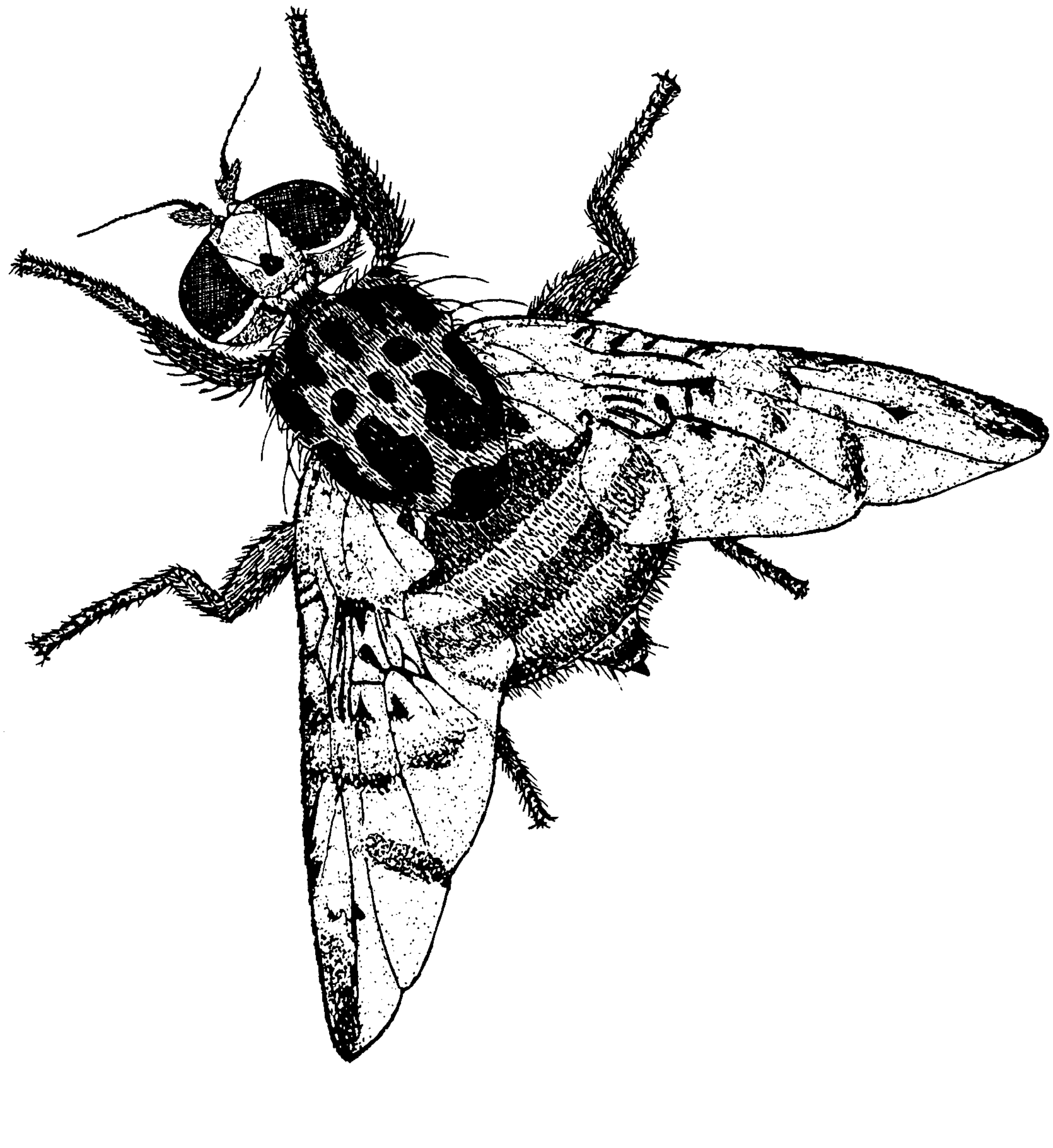
Guatemala MOSCAMED Program

Environmental Analysis—1991



Guatemala MOSCAMED Program

Environmental Analysis—1991

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I. Executive Summary

The Mediterranean fruit fly or Medfly, *Ceratitis capitata* (Wiedemann), is one of the world's most destructive agricultural pests. The Medfly (moscamed in Spanish), a pest of over 200 fruit and vegetable crops, is found in Europe, Asia, South America, Central America, Australia, and Hawaii . Because of its destructive potential, there have been major and costly efforts to eradicate the Medfly each time it was introduced into the United States, beginning in 1929. Between 1929 and 1990, federal and state expenditures for Medfly eradication programs on the mainland have totalled nearly $337 million.

In a mutually beneficial program, the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), cooperated with the Governments of Mexico and Guatemala to eradicate the Medfly in Mexico. Eradication of Medfly from Mexico was declared in 1982. To further protect the United States and Mexico from Medfly invasion and to eliminate this serious threat to Guatemalan agriculture, APHIS and the Governments of Mexico and Guatemala have jointly proposed and implemented a program, the Guatemala MOSCAMED Program, to eradicate the Medfly from Guatemala. This document is an environmental analysis of the continuing cooperative program of the Governments of the United States, Mexico, and Guatemala to control the Medfly in Guatemala. This analysis provides comprehensive consideration of: alternative program strategies and controls, unique characteristics of the Guatemalan environment, potential environmental consequences, required mitigation of environmental impacts, and applicable environmental law.

The Guatemala MOSCAMED Program has been under considerable internal and external review and is subject to modification based on emerging technologies and evolving environmental and political concerns. This analysis considers program alternatives of: no action; a Medfly barrier zone at the Isthmus of Tehuantepec, Mexico; and eradication of Medfly from Guatemala. Control alternatives considered include: no action, sterile insect technique (SIT), chemical control, cultural control, regulatory control, integrated control, biological control, and miscellaneous controls. The preferred program alternative, eradication of Medfly from Guatemala, would use proven control technologies in a systems approach, allowing selection of control methodologies which are environmentally sound and appropriate for specific conditions. It is the only alternative that has the potential for meeting the stated objectives of eliminating this serious economic pest of Guatemalan agriculture and further reducing the risk of Medfly spread to Mexico and the United States.

This analysis considers unique aspects of the Guatemalan environment, including Guatemala's human population, geography, wildlife, land use, and water resources. The potential consequences of the program are analyzed, with special focus on the program use of malathion bait. No significant adverse environmental effects of the program are foreseen for humans, including Guatemala MOSCAMED Program workers and the public. No significant adverse environmental effects of the program are foreseen for nontarget species, including nontarget invertebrates. Specific mitigative measures include procedures to advise beekeepers of planned program treatments and protective measures they can employ for their bees. Humans and other nontarget species are protected from adverse environmental effects by program design, routine safety procedures, and specially established mitigative measures.

Biological assessments (appendix 8) for species that are endangered, threatened, proposed for endangered or threatened status, or of concern to Guatemala, reveal no expected significant adverse environmental effects. In general, the "no effect" determination for most of those species is made because those species inhabit remote parts of Guatemala that are not part of the program area. Others of the described species inhabit ecological niches or habitats within program areas that are not subject to program treatments or effects, or are protected by specific protection measures such as buffer zones.

The Guatemala MOSCAMED Program has no potential for unavoidable environmental impact because of its combination of the preferred integrated control alternative, low pesticide application rates, routine operational procedures, and mitigative measures. No direct or indirect cumulative effects are foreseen as a consequence of the program.

Mitigative procedures (section VII) for the program include operational procedures to ensure the safe aerial and ground application of pesticide, the safe storage and handling of pesticide, and the protection of nontarget pollinator species. Pictorial training materials help to overcome language barriers for the public and beekeepers. An environmental monitoring plan (appendix 6) provides guidance for gathering data for use in assessing potential environmental effects of the program and allows early identification and resolution of potential problems.

In summary, the proposed Guatemala MOSCAMED Program would use proven technologies to eradicate Medfly from Guatemala in a manner that is both efficacious and environmentally sound. Comprehensive environmental analysis of the proposed program indicates that it will have no significant effect on humans or their environment.

II. Introduction

The Mediterranean fruit fly or Medfly (moscamed in Spanish), *Ceratitis capitata* (Wiedemann), is a major pest of agriculture throughout many parts of the world. Originally native to Africa, it currently occurs in Europe, Asia, South America, Central America, Australia, and Hawaii. The Medfly has been introduced to the U.S. mainland intermittently since its initial introduction in 1929; however, eradication programs (often major and costly) have prevented it from becoming established there. From 1929 to 1990, federal and state expenditures for eradication programs on the mainland have totaled nearly $337 million.

The Medfly became established in Costa Rica in 1955 and by 1977 had expanded its range from its original point of introduction to southern Mexico. In 1977, the Governments of the United States, Guatemala, and Mexico initiated a cooperative program known as MOSCAMED to eradicate the Medfly from Mexico and Guatemala and halt its northern spread. Beginning in Mexico in 1979, the MOSCAMED Program used a combination of malathion bait spray, sterile Medflies released into the wild populations, and regulatory procedures in its eradication efforts. In 1982, Mexico declared that Medfly had been eradicated from its territory, and the effort was extended into Guatemala.

MOSCAMED has been supported by the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), and the Governments of Guatemala and Mexico. Program management has been the responsibility of the MOSCAMED Commission, a cooperative organization composed of representatives of Guatemala and Mexico. The United States has signed bilateral agreements with Guatemala and with Mexico, and is now a full cooperator in the MOSCAMED Program. APHIS' annual contribution to the Guatemala eradication program averaged about $3 million between 1984 and 1990. Guatemala was allocated approximately $650,000 in the form of United States Public Law 480 Title I (Local Currency) funds during this period. The United States Agency for International Development (USAID) traditionally has administered those funds as the official donor agency of the United States Government. In 1987, USAID contracted for an environmental analysis of the Guatemala MOSCAMED Program to comply with its own internal environmental regulations. The analysis resulted in a document, the "Guatemala Medfly Environmental Impact Analysis," produced by the Consortium for International Crop Protection, 4321 Hartwick Road, Suite 404, College Park, Maryland 20740. Although it was a major and comprehensive document, APHIS review judged it inadequate for use as an APHIS decision document. Consequently, APHIS has initiated this separate analysis of the program.

The Guatemala MOSCAMED Program has been under considerable internal and external review and is subject to modification based on emerging technologies and evolving environmental and political concerns. This environmental analysis (EA) provides comprehensive consideration of: alternative program strategies and controls, unique characteristics of the Guatemalan environment, potential environmental consequences, required mitigation of environmental impacts, and applicable environmental law.

Within this EA the following three program alternatives are considered: no action, Isthmus of Tehuantepec stable barrier zone (Mexico), and eradication of Medfly from Guatemala. Control alternatives considered include: no action, sterile insect technique, chemical control, cultural control, regulatory control, integrated control, biological control, and other miscellaneous controls. The preferred program alternative, eradication of Medfly from Guatemala, would use proven control technologies in a systems approach, allowing selection of control methodologies that are environmentally sound and appropriate for existing conditions and treatment sites.

III. Purpose and Need for Proposed Action

A. Medfly Life History

The Medfly belongs to the fruit fly family Tephritidae, a group of about 4,000 species distributed throughout the tropical, subtropical, and temperate areas of the world. The larvae of many tephritids feed within fruit, and some are serious pests of agriculture. The Medfly is known to infest over 200 different fruit and vegetable crops. (Refer to table III-1 for a list of common Medfly hosts in Guatemala and Mexico.) Adult Medflies are slightly smaller than common house flies, but with distinctive color patterns on their wings. The adults feed on protein exudations from plants and generally cause only superficial scarring to host fruits and vegetables, except when the female pierces the skin of the host fruit to lay eggs. Larval damage can be extensive, however, because the larvae feed upon the fleshy interior of the host fruit.

The adult female pierces the skin of the fruit with a needle-like ovipositor (egg-laying appendage) located at the end of her abdomen. She then deposits 1 to 10 eggs in this puncture. The same puncture may be used by other females to lay eggs. Several hundred eggs have been found in a single cavity. Under favorable conditions, female Medflies produce an average of 300 or more eggs during their lifetime. The tiny elongate eggs, barely visible to the naked eye, hatch within 1 to 2 days. The larvae are slender, cream-colored maggots. Larvae complete their development in 7 to 11 days and, when mature, leave the fruit and enter the soil. By this time the fruit has usually dropped to the ground. In the soil the larvae change into pupae. Within 8 to 14 days the pupae change into adult Medflies which then emerge from the soil. After the Medflies become sexually mature (in 4 to 5 days or more depending upon temperature and diet) they mate, the females lay eggs, and the life cycle begins again.

Adults usually live 30 to 60 days, though eggs may not be produced throughout this period. A Medfly infestation can grow rapidly, progressively expanding the infested area. Under favorable circumstances, a Medfly population can increase five to tenfold each generation cycle. As the number of Medflies and incidence of infested fruit increases, the potential for Medfly dispersion into surrounding areas increases. The risk also increases for short- and long-range movement of the immature stages in infested fruit to result in satellite infestations.

B. Medfly Infestation History

1. Mexico and Guatemala

The Medfly was first detected in Central America in Costa Rica in 1955. Since then the pest has spread throughout much of Central America.

TABLE III-1. PLANT HOSTS OF THE MEDFLY IN GUATEMALA AND OTHER NEARBY COUNTRIES

Scientific name	Common name
Achras zapota	Chico
Annona muricata	Guanaba
Averrhoa carambola	Carambola
Byrsonima crassifolia	Nance
Carica papaya	Papaya
Casimiroa edulis	White sapote
Casimiroa sapote	Matasano
Chrysobalanus icaco	Icaco
Chrysophyllum cainito	Star apple
Citrus aurantiifolia	Lime
Citrus aurantium	Sour orange
Citrus deliciosa	Mediterranean tangerine
Citrus limetta	Sweet lime
Citrus maxima	Pummelo
Citrus paradisi	Grapefruit
Citrus reshni	Cleopatra tangerine
Citrus reticulata	Tangerine
Citrus sinensis	Sweet orange
Citrus spp.	Lemon, Royal lemon
Coffea arabica	Coffee
Diospyros decandra	Persimmon
Eriobotrya japonica	Medlar (loquat)
Malus domestica	Apple
Mangifera indica	Mango
Micropholis sp.	Baricaco
Muntingia calabura	Strawberry tree
Parmentiera aculeata	Cuachilote
Persea americana	Avocado
Pouteria mamose	Sapote
Pouteria viridis	—
Prunus capuli	Capulin cherry
Prunus domestica	Plum
Prunus persica	Peach
Psidium guajava	Guava
Psidium cattleianum	Strawberry guava
Pyrus communis	Pear
Sargentia gregii	Calamondin
Spondias purpurea	Purple mombin
Syzygium jambos	Rose-apple
Terminalia catappa	Tropical almond

Source: MOSCAMED (1987) and Eskafi and Cunningham (1987).

In the mid-1970s the insect was detected in Chiapas, Mexico. At that time, the USDA and the Government of Mexico began cooperating in small programs and methods development work to control the Medfly in Mexico. By the late 1970s, the control technology had improved to the extent that eradication of Medfly from Mexico was deemed feasible. In 1977, MOSCAMED was organized to stop the Medfly advance towards the north of Mexico and the United States, and to eradicate it from southern Mexico and Guatemala, and eventually to eradicate it from the remainder of Central America and Panama. With the participation of the United States, Mexican, and Guatemalan Governments, Medfly was eradicated from southern Mexico in 1982.

Reinfestation in southern Mexico occurred in 1983. It was generally concluded that the only sound option to avoid reinfestation and to protect or buffer the eradicated area was to expand the program even further, into Guatemala. However, Guatemala's participation in Medfly control was contingent upon commitment to move the Medfly barrier out of its territory, and achieve eradication in Guatemala. The Government of Guatemala has stated repeatedly and emphatically its position that Guatemala will not serve as a buffer zone to protect or solely benefit Mexico and the United States.

2. The United States

A review of the infestation history of the Medfly in the United States illustrates the success and cost of contemporary Medfly control strategies. The Medfly has invaded the United States a total of 19 times and has been eradicated 18 times.

Medfly became established in Hawaii in 1910 and was not eradicated. Since then, Hawaii has been subject to continual reinfestation pressure from other parts of the world. Its difficult terrain, sensitive areas, and delicate environment have made a comprehensive control effort using existing technology unlikely, if not impossible. Hawaii remains infested with Medfly and no eradication program is currently underway there. Intensive quarantine efforts and surveillance protect the U.S. mainland from the introduction of Medfly from Hawaii.

The 2nd through 5th Medfly outbreaks occurred on the mainland in Florida. The 2nd outbreak occurred from 1929 to 1930, and was eradicated at a cost of $7.5 million using extensive fruit stripping combined with ground spraying of lead arsenate-molasses bait, a material no longer registered for pesticide use in the United States. The 3rd outbreak occurred from 1956 to 1958, and was eradicated at a cost of $11 million using aerially applied malathion protein bait. The 4th outbreak occurred from 1962 to 1963 and was eradicated at a cost of $1 million, using aerially applied malathion bait. The 5th outbreak occurred during 1963 and was eradicated at a cost of $300 thousand also using aerially applied malathion protein bait.

The 6th outbreak occurred in Texas during 1966 and was eradicated at a cost of $370 thousand using aerially applied malathion protein bait.

The 7th, 8th and 9th Medfly outbreaks occurred in California. The 7th occurred in the Los Angeles area from 1975 to 1976, and was eradicated at a cost of $1 million with a combination of ground-applied malathion protein bait and release of sterile Medflies. The 8th and 9th outbreaks and several associated reinfestations occurred from 1980 to 1982 in the San Jose and Los Angeles areas, and were eradicated using various combinations of aerially or ground-applied malathion protein bait, fruit stripping, fenthion soil treatment, area quarantine, and release of sterile Medflies. The 8th and 9th outbreaks were eradicated at a combined cost of $100 million, through massive cooperative efforts by the federal and state governments.

The 10th through 13th outbreaks occurred in Florida. The 10th outbreak occurred in Tampa during 1981 and was eradicated at a cost of $1 million using aerial- and ground-applied malathion bait spray. The 11th occurred in Miami during 1984 and was eradicated at a cost of $1 million using aerial- and ground-applied malathion bait spray. The 12th occurred in Miami during 1985 and was eradicated at a cost of $2.2 million using aerial- and ground-applied malathion bait followed by sterile Medfly release. The 13th occurred in Miami during 1987 and was eradicated at a cost of $1.3 million using aerial- and ground- applied malathion bait followed by sterile Medfly release.

The 14th through 16th outbreaks occurred in California. The 14th outbreak occurred in the Los Angeles area during 1987 and was eradicated at a cost of $2 million using aerial- and ground-applied malathion protein bait followed by sterile Medfly release. The 15th occurred in the Los Angeles area in 1988 and was eradicated at a cost of $1.3 million using aerial- and ground-applied malathion bait followed by sterile Medfly release. The 16th outbreak occurred in the West Los Angeles area during 1988, and was eradicated at a cost of $2 milion using aerial- and ground-applied malathion protein bait followed by sterile Medfly release.

The 17th and 18th Medfly outbreaks occurred during 1989-90 in California in Santa Clara County and the Los Angeles basin. The Los Angeles Basin project involved the counties of Los Angeles, Orange, Riverside, and San Bernardino. These outbreaks were treated using aerial- and ground-applied malathion protein bait followed by sterile Medfly release. The outbreak in Santa Clara county was declared eradicated on September 14, 1990. The outbreak in the Los Angeles Basin was declared eradicated on November 9, 1990. Combined cost of the programs was $65 million.

The 19th Medfly outbreak occurred in Dade County, Florida, in 1990. Treatment in Florida consisted of applications of malathion protein bait spray followed by the release of sterile Medflies. The outbreak was declared eradicated on August 3, 1990 at a cost of $1.8 million.

Federal and state eradication expenditures for these infestations totals nearly $199 million which is equivalent to about $343 million in 1990 dollars. This figure does not include monies spent by industry for quarantine treatments and/or safeguards to satisfy quarantine restrictions, the economic impact of losing or locating alternative markets, or revenue losses of associated industries attributable to program activities.

C. Medfly Control in Guatemala—Guatemala MOSCAMED Program

Medfly is a serious problem for Guatemala. Its significance to the country's economy is well-illustrated by a September 17, 1986, memorandum of the Organismo International Regional De Sanidad Agropecuaria (OIRSA). This memorandum identified projected economic benefits to Central American countries, based on diminished crop damage should Medfly and economically important *Anastrepha* species (Mexican fruit fly, and others) be eradicated. The report estimated that crop damage to citrus, coffee, and other host crops in Guatemala will total nearly $286 million between 1987 and 1996. To separate damage attributable to Medfly from combined damage it is necessary to understand that coffee is the primary host for Medfly, and a poor host for *Anastrepha* species, and that Medfly attacks a variety of other fruit fly hosts. From OIRSA data it has been estimated that crop damage due solely to Medfly in Guatemala will approximate $176 million between 1987 and 1996. This could result in substantially increased costs of fruit and vegetables to U.S. and Latin American consumers. Additionally, the continued spread and subsequent establishment of Medfly in the United States and Mexico could result in action by foreign countries to restrict or prohibit the importation of American or Mexican agricultural products into such countries.

The major commercial host crops of Medfly in Guatemala are: coffee (throughout coffee's entire growing range); mangoes and oranges (especially in areas south of the coffee area); and apples, peaches, and pears (principally to the north of the coffee areas). In addition, Medfly attacks other crops of lesser commercial importance.

Coffee is the most prevalent Medfly host in Guatemala. The female Medfly deposits her eggs in ripe coffee berries (yellow-green to red stages) after the grain (harvestable portion) has already developed. Yield reduction in coffee crops may occur when the berries drop prematurely due to Medfly oviposition punctures. Medfly losses to coffee in Latin America have been estimated at 2.0% to 2.5%, but such estimates lack supporting data. Because coffee is such an important crop in Guatemala, just a small percentage lost due to Medfly could amount to a large sum of money. In 1987, Guatemala's coffee harvest was estimated at U.S. $384,334,702.
A 2% loss would amount to U.S. $7.7 million annually (USDA, 1989).
Many coffee growers believe that Medfly causes no noticeable reduction in coffee yield. Coffee growers consider other problems more serious than Medfly, such as prices, labor, taxes, political instability, possible agrarian reforms, other insects (coffee bean borer), and diseases (coffee rust).

Several unprocessed crops are prohibited entry into the United States from Guatemala because of the Medfly: ripe fresh tomato, green pepper, papaya, genip, cactus fruit, naranjillo, ethrog, breadfruit, ceriman, dates, and litchi. Medfly host crops which are not a host of other pest species such as *Anastrepha* spp., might be allowed entry into the United States if Medfly were eliminated from Guatemala. Elimination of Medfly from Guatemala would probably be an incentive for Guatemalan exporters to seek U.S. markets, especially for fresh ripe tomato, green pepper, and papaya. ECOTECNIA (1985) estimated that this new export market would amount to U.S. $1.5 million per year (based on 1985 prices) for Guatemalan exporters. From all 1985 and 1986 sources, the United States imported 18,791 metric tons of green peppers (U.S. value $7,238,000) and 4284 metric tons of papayas (U.S. value $5,035,000). Prospects for export of dates also look promising although Guatemala does not presently produce them.

The position of the Government of Guatemala (participation in the program only so long as progress is made to move the Medfly barrier out of Guatemala) has limited the alternatives and shaped available program strategies for the Guatemala MOSCAMED Program. As an extension of the eradication effort in Mexico, and with full cooperation of the Governments of Mexico and Guatemala, APHIS previously implemented a cooperative Medfly eradication effort in Guatemala. If the eradication program is not fully and successfully implemented in Guatemala, the Government of Guatemala might cancel the program within its territory.

The preferred program alternative, eradication of Medfly from Guatemala, would use various treatment components. To detect the presence of the pest, Medflies would be trapped using Trimedlure®, an aggregating parapheromone commonly used in such traps in the United States. The control effort would employ several strategies, relying primarily on sterile Medfly release, with ground or aerial application of malathion bait spray as an adjunct. The sterile insect technique (SIT) may provide, in certain cases, control and elimination of the target pest without general application of pesticides. Soil treatments would not be used. The treatments would be carried out by and under the control of the MOSCAMED Commission. The Guatemala MOSCAMED Program and APHIS would monitor the treatments to determine direct and indirect effects on the environment, using guidelines developed by APHIS (appendix 6). Through use of control measures, the proposed eradication program would be implemented over a 4-year period to "push" the infested area south.

Surveys undertaken in support of the current program indicate approximately 17,000 mi^2 (40%) of Guatemala's 42,000 mi^2 are currently considered infested. To reduce the risk of possible pest movement to uninfested areas, the Government of Guatemala has imposed a quarantine restricting the internal movement of Medfly and host material.

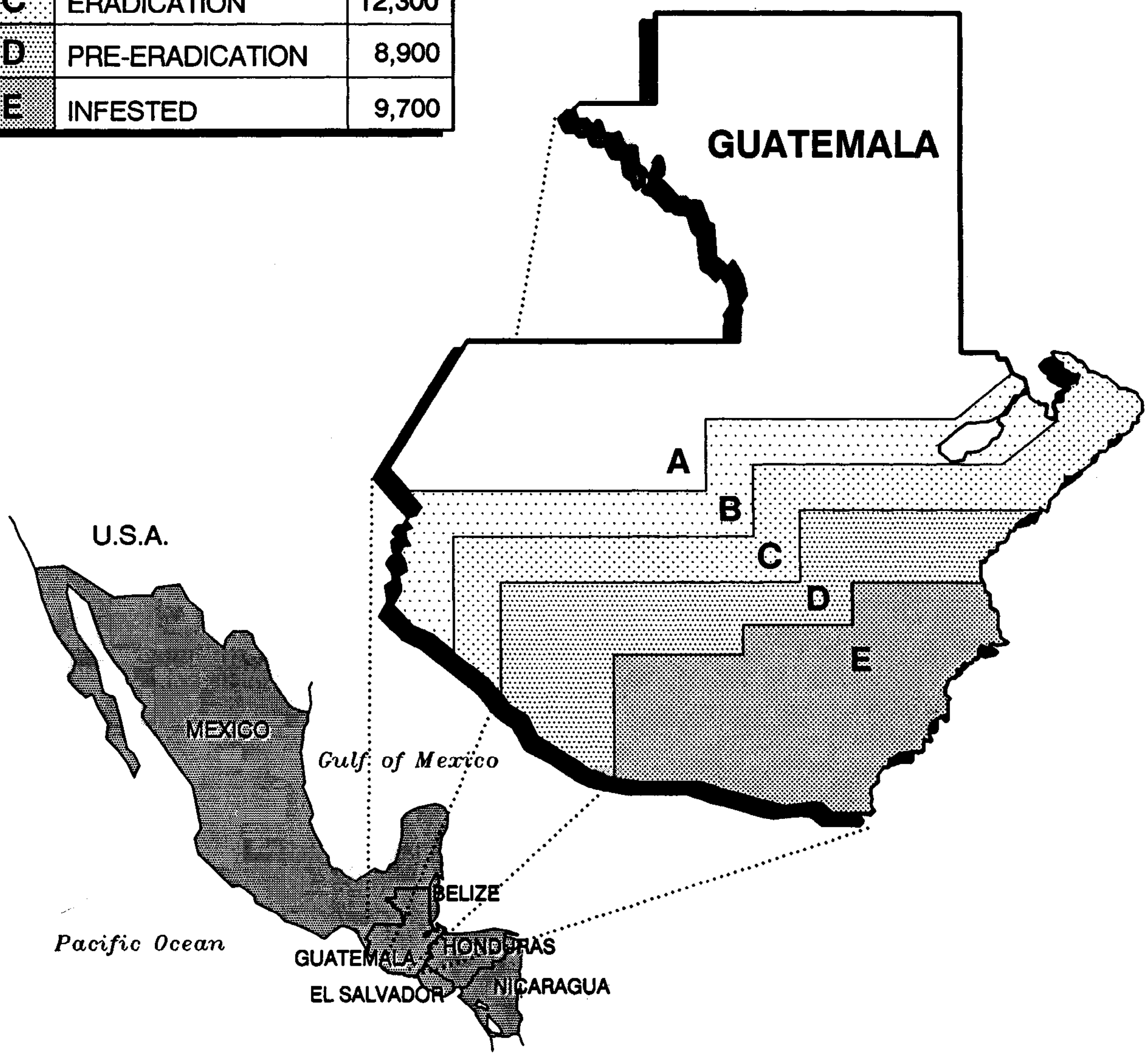
For operational and planning purposes, Guatemala has been divided into five zones (shown in fig. III-1). Those zones are known as:

FIGURE III-1. Current Guatemala Moscamed Program

ERADICATION OF MEDFLY FROM GUATEMALA

OPERATIONAL ZONES

Areas		km^2
A	MEDFLY-FREE ZONE	65,000
B	POST-ERADICATION	12,900
C	ERADICATION	12,300
D	PRE-ERADICATION	8,900
E	INFESTED	9,700



Zone "A"—the Medfly-free zone, 25,106 mi^2 (65,000 km^2), or 60% of the country;

Zone "B"—the post-eradication zone, 4,893 mi^2 (12,900 km^2) or 12% of the country;

Zone "C"—the eradication zone, 4,751 mi^2 (12,300 km^2) or 11% of the country;

Zone "D"—the pre-eradication zone, 3,438 mi^2 (8900 km^2) or 8% of the country; and

Zone "E"—the infested zone, 3,747 mi^2 (9700 km^2) or 9% of the country.

The Medfly-free zone, Zone "A", is considered generally free of Medfly although isolated outbreaks do occur there. It encompasses the northern part of the country, the Peten. Although this area constitutes the majority of Guatemalan territory, it is predominantly jungle and hence not of major economic significance to Guatemala, with the exception of the negative economic consequences to Guatemala should the pest become established there. Because of the inaccessibility of the terrain, the availability of wild hosts, political strife, and other problems associated with the area, eradication would be difficult at best. So far, efforts to prevent establishment of the pest have been successful in this region. However, in April 1988, program use of malathion bait spray for Medfly eradication was suspended pending the preparation of a comprehensive environmental analysis of the Guatemala MOSCAMED Program; by the time of the suspension, 96 of 100 outbreaks reported during 1988 had been eliminated.

The post-eradication area, Zone "B", has been characterized by frequent outbreaks of Medfly, controlled in the past through malathion bait spray in combination with the sterile insect technique. In April 1988, at the time malathion bait use was suspended, a total of 402 of 440 outbreaks had already been successfully controlled that year in Zone "B". Suspension of malathion bait use resulted in the Guatemala MOSCAMED Program placing increased emphasis on the sterile insect technique to provide a "biological barrier" in this area to protect the Medfly-free areas (and previous gains under the Guatemala MOSCAMED Program) from infestation. This is considered a "holding action" at best, with territory being lost slowly back to Medfly.

Practically no control work has been done since 1988 in the eradication area, Zone "C", and in the infested area, Zone "D", due to concentration of available resources in maintaining the "biological barrier" to protect the Medfly-free areas from further infestation.

D. Authority for Federal Participation

APHIS authority to cooperate in international pest control programs is based upon provisions of the Organic Act of 1944 (7 USC 147a(b) section 102(b)). This Act authorizes the Secretary of Agriculture to cooperate with the governments of all countries of the Western Hemisphere, or the local authorities thereof, and with international organizations or associations, in carrying out necessary surveys and control operations in those countries in connection with the detection, eradication, suppression, control, and prevention or retardation of the spread of plant pests.

E. Legislation Affecting Environmental Analysis

APHIS has published guidelines for implementing the procedural provisions for the National Environmental Policy Act (NEPA). (See 44 FR 50381-50384, 51272-51274.) These guidelines comply with the Council of Environmental Quality (CEQ) regulations for NEPA implementation and applicable Department regulations. (See 40 CFR Parts 1500-1508, and 7 CFR Part 1B and 1C.)

Executive Order 12114 (EO 12114) of January 4, 1979, entitled "Environmental Effects Abroad of Major Federal Actions" (see 44 FR 1957-1962), is the primary authority affecting development of the environmental analysis for the Guatemala MOSCAMED Program. EO 12114 applies to proposed major federal actions abroad and furthers the purpose of NEPA, the Marine Protection Research and Sanctuaries Act, and the Deepwater Port Act. Its objective is to "provide information for use by decisionmakers, to heighten awareness of and interest in environmental concerns and, as appropriate, to facilitate environmental cooperation with foreign nations" (section 1-1). EO 12114 "represents the United States Government's exclusive and complete determination of the procedural and other actions to be taken by Federal Agencies to further the purpose of the National Environmental Policy Act with respect to the environment outside the United States, its territories, and possessions" (section 1-1).

Section 2-3(c) of EO 12114 states that agencies shall establish procedures and prepare an environmental document for "major Federal actions significantly affecting the environment of a foreign nation which provide to that nation: (1) a product, or physical project producing a principal product or an emission or effluent which is prohibited or strictly regulated by Federal law in the United States because its toxic effects on the environment create a serious public health risk. . .". Although the Guatemala MOSCAMED Program has not been determined to significantly affect the environment of Guatemala, the use of chemical pesticides (regulated by federal law in the United States) in the program suggests a need for analysis. Section 2-4(b)(iv) provides that the agency shall determine the type of document to be prepared: a bilateral or multilateral environmental study;

or a concise review of the environmental issues involved, including environmental assessments, summary environmental analysis or other appropriate document. The organization and scope of this analysis are similar to those of analyses for APHIS programs of equal complexity cited in the United States. This analysis has been prepared in accordance with the Executive Order 12114 and all applicable environmental statutes.

Although most reviewers understand the applicability of EO 12114 to the Guatemala MOSCAMED Program, there is a frequent lack of understanding of the distinction between the procedural aspects of NEPA and those of EO 12114 (particularly with regard to the type of documentation that should be prepared). EO 12114 establishes "exclusive" authority (section 1–1) over procedural actions to be taken by a federal agency for certain actions; in other words, it preempts procedures established for other types of actions (for example, NEPA-related procedures which apply only to actions within the United States). EO 12114 is solely for the purpose of establishing internal procedures for federal agencies to consider the significant effects of their actions on the environment outside the United States (section 3-1), and authorizes them to design and implement their own procedures (section 2-3).

EO 12114 specifically designates (section 2-4) the types of environmental analyses that are acceptable and provides guidance (section 2-4 (b)) for selection of the proper documentation based upon the category of proposed federal action; for actions such as the Guatemala MOSCAMED Program, it requires a bilateral or multilateral environmental study or a concise review, such as an environmental assessment, summary environmental analysis, or other appropriate document.

Procedures established in EO 12114 require an environmental impact statement when a major federal action could significantly affect the environment of the global commons outside the jurisdiction of any nation (e.g., the oceans or Antarctica). No global commons impacts are apparent with this program. Since the Guatemala MOSCAMED Program resides entirely within Guatemala and program actions would have no impact whatsoever on multinational territory, the preparation of an environmental impact statement is not appropriate. Although the environmental analysis for the Guatemala MOSCAMED Program adheres to accepted format for an environmental impact statement, the recommendations of some reviewers to prepare an EIS are considered inappropriate because EO 12114 directs that another type of document be prepared.

For the purposes of EO 12114 (section 3-4), the term environment means the natural and physical environment and excludes social, economic, and other environments; therefore, this analysis does not include, but instead incorporates by reference, an economic analysis, "Economic Analysis of the Medfly Program in Guatemala," prepared by USDA, APHIS, Policy and Program Development (USDA, 1989).

In summary, the authorities that establish procedures for environmental analyses for programs such as the Guatemala MOSCAMED Program include Executive Order 12114, the National Environmental Policy Act (NEPA), the Council of Environmental Quality (CEQ) regulations for NEPA implementation (40 CFR 1500-1508), applicable Departmental regulations (7 CFR Part 1B and 1C), and APHIS Guidelines Concerning Implementation of NEPA Procedures (44 FR 50381-50384, 51272-51274). The EO 12114 is the primary authority affecting procedures to be followed in analyzing a program such as the Guatemala MOSCAMED Program. The Executive Order 12114 represents the U.S. Government's exclusive and complete determination of the procedural and other actions to be taken by federal agencies for the environmental analysis, determines the kind of documentation to be prepared, and allows the agencies latitude in the extent of documentation to be prepared.

F. Review of Previous Environmental Analyses of This Program

1. The 1987 APHIS Guatemala MOSCAMED Draft Environmental Assessment

In July 1987, APHIS prepared a draft environmental assessment for the Guatemala MOSCAMED Program, analyzing potential environmental effects of the cooperative Guatemala MOSCAMED Program. The "Draft Environmental Assessment, MOSCAMED Mediterranean Fruit Fly Eradication Program" analyzed specific control alternatives: no action, sterile insect technique, chemical, cultural, and integrated pest management. The discussion on affected environment and environmental consequences analyzed human health risks, water resources, wildlife, endangered and threatened species, soil, nontarget invertebrates, noise, air pollution, and malathion residues. Based on internal review and review by the public, the document was considered lacking in essential data; although the document analyzed appropriate control strategies, it did not fully consider program alternatives and lacked detail in some risk categories. The 1987 APHIS Guatemala MOSCAMED Draft Environmental Assessment was the forerunner of the current APHIS document.

2. The 1988 USAID Environmental Impact Analysis

The 1987, APHIS draft environmental assessment was reviewed by the U.S. Agency for International Development (USAID) to determine feasibility of USAID support through Public Law 480 Title I (Local Currency) funding. USAID determined that the 1987 APHIS document did not meet USAID internal standards for adoption. Therefore, USAID contracted the Consortium for International Crop Protection (CICP) to conduct a comprehensive environmental impact analysis (EIA) for the Guatemala MOSCAMED Program. An EIA is the USAID functional equivalent of an environmental impact statement (EIS). USAID published the "Guatemala Medfly Environmental Impact Analysis" in July, 1988. The USAID EIA has been used as a reference document by APHIS in preparing its current analysis, but, for reasons that will be discussed later, was not considered adequate for adoption or use as an APHIS decision document.

a. The 1988 USAID Environmental Impact Analysis as a Program Review Document

The EIA was primarily devoted to reviewing operational procedures of the Guatemala MOSCAMED Program, identifying potential environmental impacts of the program, and suggesting mitigation procedures for program activities. The EIA compares in many respects to program review documents prepared by APHIS. Several of its observations and recommendations were considered valid, and were the basis for instituting change in program procedures.

Major findings of the document are positive and reflect well on the Guatemala MOSCAMED Program's operational control. The EIA observed that there were no documented significant adverse environmental impacts on the general public, most program workers, or the natural environment from the program. The EIA team identified 65 (from EIA Executive Summary) or 66 (from EIA table IV-1) potentially adverse environmental impacts that could arise from the Guatemala MOSCAMED Program. Of that number, about half were determined to present no significant adverse environmental effects, nearly another half resulted in no conclusion being drawn about effect because of lack of data, and a few resulted in potentially significant adverse effects for employees who mixed, used, or applied program chemicals. The risks to program employees involved: (1) use of inappropriate chemicals to treat vehicles (rectified immediately and verified by the EIA team), (2) inappropriate use of fumigation chambers by employees and lack of safety equipment (since rectified by the program), and (3) failure to observe appropriate safety precautions and use proper protective clothing (now required by the program) by a few employees who mixed, loaded, or applied malathion bait spray. These risks, discussed in the EIA, and mitigative measures proposed to minimize them are analyzed in detail in this analysis of the Guatemala MOSCAMED Program.

Potential environmental impacts of the Guatemala MOSCAMED Program were considered in the EIA. The EIA did not substantiate any significant adverse impact on biological diversity, nontarget species (including arthropods, honeybees, wild vertebrates, and native plants), crop plants, ecologically sensitive areas, natural aquatic ecosystems, or aquaculture. Malathion bait applications were found to have little or no effect on nontarget arthropods regarding numbers of individuals, species, families, individuals per species, or species diversity (p. 53). Field testing of the malathion bait in Guatemala produced no evidence that it was attractive to honeybees (p. 47), but the EIA identified other factors that could have adversely affected populations of native honeybees, including tracheal mites, American foulbrood disease, and displacement by Africanized honeybees (p. 48-49). No substantiated fish kills or other problems in aquatic habitats were found (p. 65). The EIA team acknowledged literature (usually not site-specific in nature) which indicated that potential environmental impacts could exist and repeatedly cited interviews with farmers and others alleging adverse effects from the program in Guatemala, but provided no empirical data to confirm that adverse impacts resulted from the program.

b. The 1988 USAID Environmental Impact Analysis as a Decision Document

The EIA produced by the Consortium for International Crop Protection was a significant and detailed document with major value as a review of current program operations. Despite this value and the additional insight it added to the program, it lacked a substantive analysis of realistic program alternatives. Accordingly, APHIS chose to reevaluate its 1987 draft assessment within the perspective of the information added by the EIA. This APHIS analysis is the result of that reevaluation.

The current APHIS analysis has been prepared with the intent of providing resolution for issues identified in the EIA, and is intended to be appreciably more concise and analytical than the EIA. This analysis is designed to meet the environmental analysis needs of APHIS and its cooperators in the Guatemala MOSCAMED Program.

IV. Program Alternatives

A. Discussion and Analysis of Program Alternatives

1. No Action

a. Characterization

Under the no action alternative, the existing Guatemalan component of the MOSCAMED Program would be terminated and APHIS would discontinue cooperative actions of any kind to control Medfly in Guatemala. The cooperative agreement with Guatemala would be canceled. Guatemala MOSCAMED Program personnel in Guatemala would be discharged. All physical assets accumulated in the Guatemala MOSCAMED Program would be reclaimed by APHIS and the Government of Mexico under the current agreement. The transfer of technology to control economically important fruit flies would diminish. Efforts to strengthen government infrastructures to detect, exclude, or control plant pests would be significantly reduced.

b. Discussion

Under this alternative, efforts to control Medfly populations would be left to the Government of Guatemala. Without major intervention by the Government of Guatemala, Medfly control would diminish greatly in scope, resulting in a resurgence of Medfly in areas where Medfly hosts exist within the country. If Guatemalan Medfly control efforts failed and Medfly were reintroduced into Mexico, there would be an increased threat to U.S. agriculture. The United States would need to maintain an exterior quarantine on host commodities from Guatemala, and potential markets for Guatemalan produce in the United States, and possibly other countries, could be lost.

The Medfly rearing facility at San Miguel Petapa, Guatemala, is the greatest physical asset of the Guatemala MOSCAMED Program. Its value is estimated at $2.4 million. Under the no action alternative, a portion of U.S. funds now being spent in Guatemala would be diverted to support Mexico's control efforts, while other assets would be used to upgrade Mexico's rearing facility or establish an additional rearing facility. Another important asset to be transferred to Mexico would be the MOSCAMED vehicles, estimated at about $400,000. Including laboratory and office equipment, the total value of physical assets to be relocated following termination of the MOSCAMED Program would not exceed $3 million. According to the current MOSCAMED agreement, the assets belong to the respective governments that contributed them. For the most part, they belong to either the United States or Mexico.

As of May 1988 the Guatemala MOSCAMED Program employed about 1,000 people in Guatemala. A substantial portion of them have been trained in different aspects of pest management. Once discharged, many, if not most, could seek jobs related to their training and experience. Some could secure related jobs in pest management in the public or private sectors. Their new employers could benefit from the training and experience workers received while previously employed by the Guatemala MOSCAMED Program. Indirect costs and benefits now associated with the Guatemala MOSCAMED Program would end as soon as the program stopped.

Potential benefits associated with this alternative include: (1) relocation and utilization of indigenous personnel, possibly for other Guatemalan-sponsored pest management programs; (2) redirection of funding to other necessary programs; and (3) freedom from domestic Medfly regulatory constraints.

Potential disadvantages include: (1) increased outbreaks and opportunities for establishment of Medfly in Mexico and the United States; (2) increased crop losses for Guatemala, Mexico, and the United States; (3) loss of potential agricultural export markets for Guatemala, and possibly the United States and Mexico; (4) loss of employment opportunities for some Guatemalan citizens; (5) increased eradication, suppression, and regulatory efforts required for Mexico; (6) increased commercial use of pesticides in an uncoordinated manner to control Medfly in Guatemala, with accompanying potentially adverse environmental impact there; (7) reduced international cooperation among Guatemala, Mexico, and the United States in pest management; (8) loss of the advantages gained thus far in the Guatemala MOSCAMED Program's Medfly eradication efforts in Guatemala; and (9) loss to Guatemala of laboratory resources valued at $3 million.

c. Effectiveness

The combination of no action and no intervention by the Government of Guatemala would result in a resurgence of Medfly in Guatemala. Since commercial growers may lack the organization or resources for a concerted effort against Medfly in Guatemala, this could result in continued significant annual crop losses for coffee, mango, orange, apple, pear, and peach crops. Potential markets for Guatemalan produce in the United States and other countries could be lost indefinitely.

For Guatemala, a resurgent Medfly population also could result in less crop diversification, increased soil depletion, destruction of additional forest areas, and the need for early-season harvesting of crops. Peach, apple, and pear production in the highlands could be adversely impacted, resulting in negative political and social consequences for indigenous cooperative farming communities. USAID crop diversification efforts in Guatemala and elsewhere in the region could become jeopardized.

An increase in uncoordinated commercial chemical control applications in Guatemala and Mexico would likely occur, with potential adverse environmental consequences. Those consequences would depend on the pesticides used (anything available within those countries) and the manner in which they are used.

An increased threat to the agriculture of Mexico and the United States would result from a resurgent Medfly population in Guatemala. Termination of the Guatemala MOSCAMED Program could result in Guatemala severing its Medfly eradication agreement with Mexico and the United States. If eradication is abandoned in Guatemala, Mexico would likely establish a Medfly barrier at the Isthmus of Tehuantepec (See Program Alternative 2). According to estimates by the Government of Mexico, crop losses could still be an estimated $5 to $10 million per year from regions southeast of the barrier. The estimated annual cost of a barrier at Tehuantepec would be $4 million. Mexico might have financial difficulty maintaining a barrier permanently without U.S. support, although Mexican Agricultural Ministry officials have affirmed their commitment to keeping Mexico free of Medfly.

2. Isthmus of Tehuantepec Stable Barrier Zone

a. Characterization

This alternative would be characterized by withdrawal of MOSCAMED activities to the Isthmus of Tehuantepec in Mexico and the creation and maintenance of a stable barrier zone to deter northern spread of the Medfly throughout Mexico. The Isthmus of Tehuantepec barrier would extend from an area just slightly south of the town of Tehuantepec on the Pacific coast to the town of Coatzacoalcos on the Atlantic coast (a distance of approximately 210 km). This area is approximately 325 km northwest of Guatemala. The Medfly did not infest the area between Tehuantepec and Coatzacoalcos any time before or during the Mexico MOSCAMED eradication efforts. Refer to figure IV-1 for a depiction of the Isthmus of Tehuantepec Stable Barrier Zone.

b. Discussion

The Isthmus of Tehuantepec is considered the only reasonable choice of location for a barrier zone in Mexico for a number of reasons, including: (1) the low-host abundance—fewer susceptible hosts, primarily guava, citrus, and mango; (2) the length and width of the zone—the smallest, thereby presenting the lowest cost and least logistical effort to support; (3) the least potential impact on agricultural practices and environmentally sensitive areas; and (4) the ability to maximize the effectiveness of regulatory control while minimizing the need for chemical control. See section IV-B for a description of other locations considered and eliminated.

The barrier zone would consist of two parallel component zones: a southeastern eradication zone and a northwestern "high-risk" zone. The barrier would be considered successful if the Medfly did not move northwest beyond the high-risk zone. The eradication zone would receive ground and aerial applications of malathion bait spray, releases of sterile Medflies, intensive Medfly monitoring, and selective fruit destruction aimed toward complete eradication of the Medfly. The zone would be 30 km wide, since this is twice the estimated maximum distance an adult Medfly travels during its lifetime if assisted by wind.

FIGURE IV-1. Program Alternative 2

ISTHMUS OF TEHUANTEPEC STABLE BARRIER ZONE

The high-risk zone, abutting the eradication band to the north, would be 75 km wide in an area where the Medfly had been eradicated or had not previously existed. It essentially would be treated the same way the post-eradication zone is now treated in the Guatemala MOSCAMED Program, since it would be close to infested areas and highly susceptible to Medfly invasion. Actions in the high-risk zone would include rigorous monitoring (Medfly trapping and limited fruit sampling) and selective use of malathion bait spray followed by sterile Medfly releases to eliminate any Medfly infestations detected.

Control strategies used in this alternative would involve continuous suppression in the eradication zone and outbreak suppression in the high-risk zones. Continuous suppression would consist of: (1) monitoring (one survey trap per km^2 with weekly inspections), and fruit sampling (average 0.5 kg per km^2 per week); (2) aerial strip application of malathion bait as indicated by monitoring procedures, and substituting use of ground application and bait-station treatment when aerial treatment is impractical; (3) sterile insect technique (an average of 2,500 sterile Medflies released per hectare (2.471 acres) per week); and (4) selective fruit collection and destruction. Pesticide use and impact on human health and environment would be monitored on a continuous basis. Monitoring would take place within the barrier zone. Parallel sampling outside the barrier would be used for comparison and to assess potential pesticide impacts in the environment.

Two costs are attributed to this alternative: an "investment" cost (to create the barrier) and an "operating" cost (to permanently maintain the barrier). Investment costs for the Isthmus of Tehuantepec barrier would be practically zero; because of the Guatemala MOSCAMED Program, such a barrier is already in place. Operating costs are estimated at $4 million for the Isthmus of Tehuantepec barrier.

Enforcement of quarantines would be essential to the Isthmus of Tehuantepec Stable Barrier Zone. Both the southern and northern boundaries of the eradication zone would be safeguarded by quarantine inspections and treatment stations. All traffic and commodities entering the eradication zone from the south and all traffic and commodities exiting (either from the eradication zone or the high-risk zone) for points north would be subjected to inspection and possible treatment.

Theoretically, Mexico and the United States would accrue the economic benefits derived from this alternative since the barrier would not protect Guatemala from Medfly. Guatemala would be faced with crop losses due to Medfly estimated from OIRSA data to approximate $176 million between 1987 and 1996. They would have to bear the burden of control costs through commercial or government funding, and could face the indefinite loss of potential export markets. Mexico would be internally divided and faced with infestation in new areas and rapid reinfestation of major agricultural areas southeast of the barrier zone, while areas to the northwest could be protected and minimize export restrictions.

Realistically, however, no benefits of any kind—export benefits, aggregate benefits (political and human capital), or employment benefits—can be attributed to this alternative for Guatemala. The Government of Guatemala has stated that it would not support an alternative that would benefit only Mexico or the United States.

c. Effectiveness

It is unlikely that a stable barrier zone, employing quarantines and control measures as discussed for this alternative, could result in effective long-term containment of the Medfly. Even in the United States, with significant controls on the importation of host commodities and stringent enforcement of quarantines, a number of Medfly infestations have arisen.

Absolute control over commercial and noncommercial movement of Medfly host commodities would be impossible to achieve. There is clear evidence that quarantine measures do not eliminate completely the movement of those commodities through airports, seaports, and land border ports.

Land borders or barriers frequently impose greater risks with respect to the availability of suitable host material to serve as sites for new infestations. There is also the likelihood that infested cargo not intercepted at land quarantine stations would be transported great distances and widely distributed through established marketing channels. This cargo could be redirected northward into Medfly-free areas and border cities along the U.S.-Mexico border. In contrast, air or sea cargoes of perishables are generally shipped and distributed close to their ultimate destinations. Agricultural commodities transported solely by ground freight often go great distances to their markets.

The regulatory actions needed to support the Isthmus of Tehuantepec Stable Barrier would be critical to the efficacy of this alternative. Considering the amount of agricultural produce that transits the Isthmus of Tehuantepec and the inherent difficulties in enforcing an internal quarantine, APHIS analysts have predicted that Medfly could permanently breach the stable barrier (establishing isolated populations in northern Mexico) within as little as 1½ years from the date of establishment of the barrier. The uncertain success of the Isthmus of Tehuantepec Stable Barrier Zone would be a major factor against its selection as the preferred program alternative.

3. Eradication of Medfly From Guatemala (Preferred Program Alternative)

a. Characterization

Under the eradication alternative, the Guatemala MOSCAMED Program would eradicate the Medfly from all of Guatemala. This alternative establishes for the purpose of the control program five zones of operation, through which the program would move as the Medfly is progressively eradicated from Guatemala. Assuming that control strategies similar to those used in the recent past are employed (this analysis considers program and control strategies separately for maximum flexibility in decisionmaking), that there is an ample supply of sterile Medflies, and that adequate program resources are allocated, Guatemala MOSCAMED Program personnel believe that it would be possible to eradicate the Medfly from Guatemala in a 4- or 5-year period.

This strategy assumes that the eradication effort would begin at a time when Medfly populations approximate 1988 levels. However, sterile Medfly production is the limiting factor and it would be difficult to eradicate the Medfly in 4 years or less given current production levels. The proposed eradication areas by year of project activity are shown in figure IV-2.

b. Discussion

The Medfly would be eradicated from Guatemala in a comprehensive control program that would eliminate the pest in stages from portions of the country until completely gone.

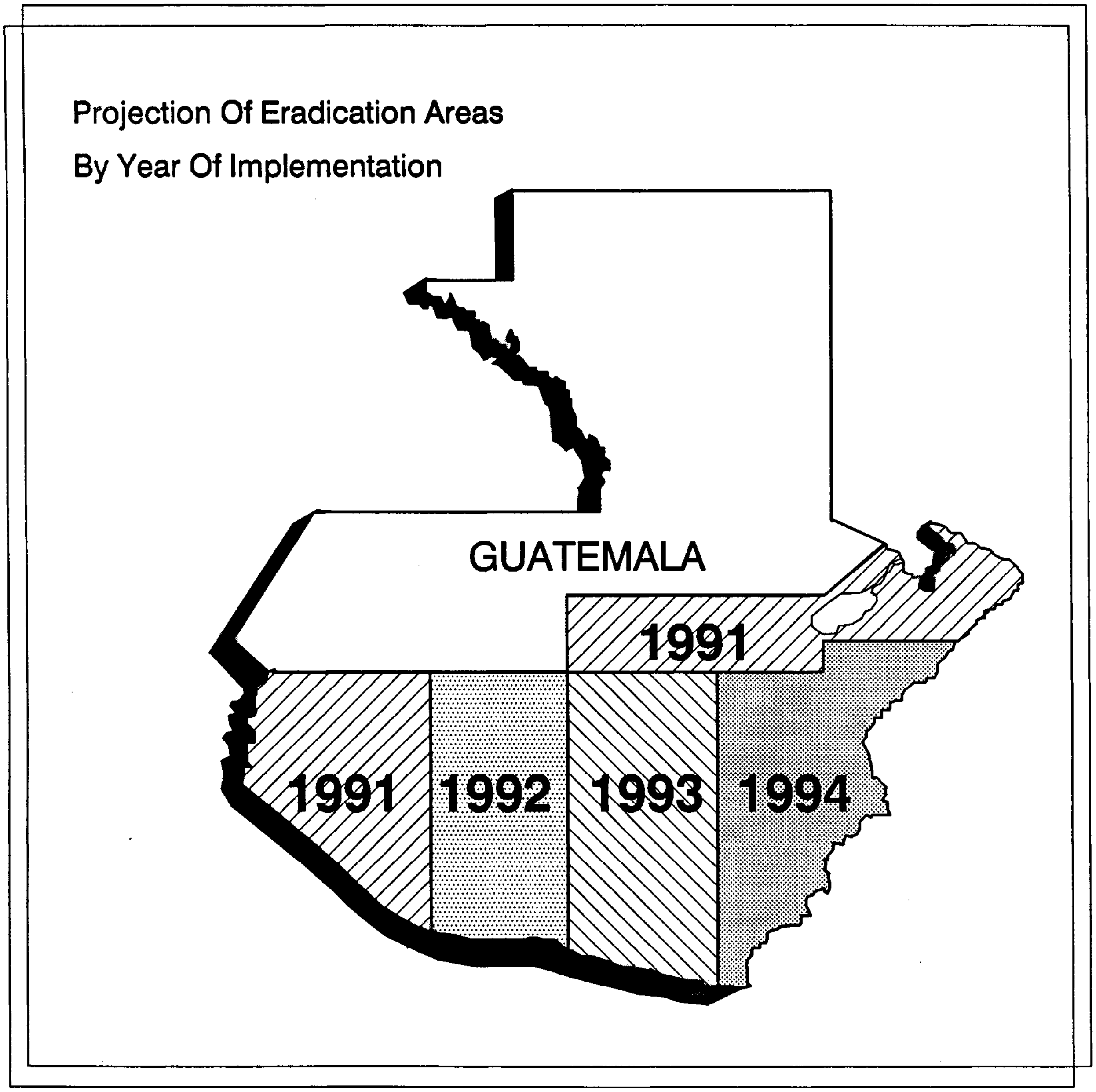
The Guatemala MOSCAMED Program has partitioned Guatemala into the following five zones to show status of Medfly eradication at a given time: a Medfly-free zone, Zone "A", an area considered generally free of Medfly; a post-eradication zone, Zone "B", an area where Medfly has been eradicated but which is close to other infested areas; an eradication zone, Zone "C", an area where eradication measures are being used; a pre-eradication zone, Zone "D", an infested area where extensive monitoring is being done in preparation for eradication; and an infested zone, Zone "E", an area which is generally infested and where no eradication effort is underway. (These areas correspond exactly to the existing five zones, as depicted earlier in fig. III-1.)

As areas are eradicated, the zones would move further and further southward, until Medfly is eliminated from Guatemala. Eradication of Medfly from all or any one area of Guatemala would be judged successful if no wild Medflies were detected by Medfly survey traps, fruit samples, or other methods following a full year of intensive sampling immediately after the eradication measures are terminated. Following eradication from Guatemala, cooperation with Guatemala's neighbors, Mexico, Belize, Hondouras and El Salvador would shape the nature and future of protective measures designed to keep Guatemala Medfly free. These countries have expressed interest in Medly control through their respective ministries of agriculture, through joint resolutions passed in CIRSA/OIRSA and CORECA (refer to glossary, appendix 2).

The efficacy of the quarantine program may greatly influence the outcome of the eradication effort. Curbing all movement of Medfly infested fruits and vegetables into Medfly-free zones is probably not possible while other Central and South American countries are infested with Medfly. Eradication of the Medfly from Guatemala, or from all of Mexico and Central America, will not eliminate but will reduce the threat of the insect entering the United States.

FIGURE IV-2. Program Alternative 3 (Preferred Alternative)

ERADICATION OF MEDFLY FROM GUATEMALA



The U.S. quarantine program has reduced the incidence but not prevented Medfly introduction onto the U.S. mainland. Noncommercial movement of host material by the traveling public and the smuggling of host material in conjunction with unauthorized human entry into the United States are thought to be contributing factors to Medfly introduction. Only a small percentage of the total Medflies intercepted at U.S. mainland ports are attributed to the Guatemalan infestation; however, the interception statistics may be biased for reasons such as travelers reporting intermediate stops as origination points.

If the Medfly were eradicated in Guatemala, the farmers would still have to contend with injurious *Anastrepha* spp. These fruit flies attack some of the same fruits as the Medfly. If Guatemala were Medfly free, it still could not export *Anastrepha* host fruits to the United States unless USDA-approved commodity treatments exist for the host fruits.

Potential benefits of the eradication alternative would fall into the following four categories: (1) elimination of crop losses caused by the Medfly; (2) relaxation of import constraints by countries that restrict products from Medfly infested areas; (3) aggregate benefits (political and human capital benefits) such as improved international cooperative linkages, strengthened institutional infrastructures to cope with and resolve plant and animal health problems through technology transfer; (4) development and maintenance of a pest emergency response capability and training for program workers; and (5) direct program benefits, such as employment. The first four are permanent benefits. The fifth benefit would continue into posteradication phases because of the need for continuous detection and surveillance against possible reintroduction of Medfly.

A potential disadvantage of this alternative is the inherent difficulty of maintaining an effective quarantine program to prevent Medfly from entering Guatemala from other parts of Central America. The continued need to treat for other pests, including *Anastrepha* spp., is not seen as a disadvantage, since it would be required under any of the program alternatives.

c. Effectiveness

The eradication program alternative has the potential to completely eliminate the Medfly from Guatemala, thereby significantly decreasing economic losses to Guatemala and reducing the risk of Medfly spread to Mexico and the United States. Eradication techniques have been employed successfully in Mexico and the United States to control and eliminate the Medfly in locations where it had been introduced or established.

Successful eradication in Guatemala will be dependent upon the ability to attain subordinate operational objectives (zonal progression through Guatemala), the appropriate availability of control alternatives under varying site-specific conditions, and the successful employment of quarantine measures to exclude Medfly from eradicated areas. Continuous monitoring of eradicated areas would confirm eradication and identify potential new introductions of Medfly, which, if attended to early, could be eliminated with minimal effort and minimal potential adverse environmental effect.

Occasional introductions of Medfly in Guatemala may need to be eradicated with approved control alternatives, but the level of control needed to eradicate those introductions would not even begin to approach the magnitude needed if Medfly were allowed to exist within Guatemala. Efforts to suppress it to subeconomic levels would be widespread and inconsistent.

Maintenance of a Medfly-free Guatemala is dependent upon Guatemala's ability to enforce quarantine measures on its international borders with El Salvador and Honduras. Guatemala's international borders are considered more likely to constitute an effective barrier to Medfly than the stable barrier zone in Mexico. This is because the movement of people, conveyances, and commodities across international borders is generally controlled through the cooperative efforts of the neighboring countries' governments and regional plant and animal health organizations, e.g., OIRSA. Also, there is a greater need for the movement of agricultural commodities, including commercial fruit, between areas within a country, rather than from country to country.

B. Program Alternatives Considered and Eliminated

1. Guatemala-Wide Suppression

Guatemala-wide suppression could be attained through any or a combination of control techniques, including: aerial- and ground-applied malathion bait, sterile insect technique, cultural control, and regulatory control. The objective of country-wide suppression would be to maintain Medfly populations at levels that would not cause crop losses exceeding some predetermined economic threshold.

This alternative was eliminated from further consideration due to four basic reasons. First it fails to meet Guatemala's objective of eradication. Suppression only attempts to reduce populations of a pest species to a level economically tolerable. The position of the Government of Guatemala is that they would participate in the program only so long as progress is made to move the Medfly barrier out of Guatemala, and the Guatemala-wide Suppression Alternative would fail to achieve their goal.

Second, this alternative's continual use of pesticides contributes to the potential for adverse environmental effects. In order to produce Medfly-free crops, substantially greater amounts of pesticide would be required in each orchard and field.

Third, the mere presence of Medfly within the country would result in continued quarantine sanctions by other countries including the United States. Exportation of certain crops to Medfly-free countries would require fumigation. This would involve additional pesticide usage and likely environmental contamination.

The fourth concern involves the logistical and economic hardships imposed by a permanent suppression program in Guatemala. Agricultural commodities of the type infested by Medflies experience some damage and deterioration due to fumigation treatment. Fumigation of citrus can easily lead to a loss of 15% of the treated crop. This results in higher prices to the consumer and loss of markets for the Guatemalan producers.

2. Guatemala Stable Barrier Zone

This alternative would involve the establishment and maintenance of a permanent mesoamerican Medfly barrier to deter northern spread of the insect. Choice of location of the stable barrier would depend on numerous factors, including: (1) status of Medfly and organized efforts to eradicate it, (2) geography and topography, (3) logistics, including access by control and survey crews, etc., (4) Medfly host abundance, (5) crops saved and lost, (6) climate, and (7) location of environmentally fragile or protected areas. The mid-Guatemalan barrier could essentially encompass the present Guatemala MOSCAMED Program eradication zone, with the objective of confining Medfly to the area it presently occupies in Guatemala.

A theoretical barrier might consist of two parallel zones—the southeastern "eradication zone" and the northwestern "high risk zone"—extending across Guatemala. The eradication zone would receive ground and aerial applications of malathion bait spray, high density releases of sterile Medflies, intensive Medfly monitoring, and fruit destruction aimed toward complete annihilation of the medfly. The eradication zone would be 30 km (18.6 mi) wide and involve over 1,400 ha (5,500 mi^2). The high risk zone, abutting the eradication band to the north, would be 75 km (46.6 mi) wide in an area where the Medfly had been eradicated or had not previously existed. This would involve an area of approximately 4,400 ha (17,000 mi^2). Actions in the high risk zone would include rigorous monitoring (medfly trapping and fruit sampling) and selective use of malathion bait spray and sterile males to eliminate any Medfly infestations detected.

A mid-Guatemalan barrier is unacceptable for a variety of reasons. The first involves the difficulty and associated high costs of maintaining the barrier indefinitely. Agricultural commodities of the type infested by Medflies experience some damage and deterioration due to fumigation treatment resulting in higher prices to the consumer and loss of markets for the Guatemalan producers.

The local population would also be affected in other aspects. Residents in the treated areas would be continually subjected to applications of malathion bait spray. Potential for public resentment and a willful noncompliance with regulatory measures could develop. An understanding of the chemicals used, effects of the bait spray, reasons for the Guatemala MOSCAMED Program, and spraying patterns, would lead to an increased acceptance of the barrier control tactics. The difficulties would be great in educating the residents and any one who might travel through these areas concerning the importance, and the procedures of the project. Although the official language is Spanish, there are an additional 23 Indian languages spoken in Guatemala. Illiteracy is another problem, for the illiteracy rate is estimated to be about 52%.

Another problem would be the failure to meet Guatemalan objectives of eradication. The position of the Government of Guatemala is that they would participate in the program only so long as progress is made to move the Medfly barrier out of Guatemala, and the Guatemala Stable Barrier Zone Alternative would fail to achieve their goal.

Continual use of pesticides produces a potential for adverse environmental effects. During a Medfly eradication program in northern California during 1981, some areas received weekly applications of malathion bait over a 20-week period. One of the side effects of the treatment was a decrease in the number of predatory and parasitoid insects with an accompanying increase in the number of herbivorous insects (Troetschiler, 1983; Ehler and Endicott, 1984). If malathion application in Guatemala would become continuous, outbreaks would undoubtedly occur by insects which had previously been held in check by the predatory and parasitic insects. Additional pesticides would be necessary to control these new crop pests, thus increasing the overall environmental impact of the Guatemala Stable Barrier Zone Alternative. Therefore, this alternative has been eliminated from further analysis.

3. Nonchemical Pest Management

This alternative would involve the management (not eradication) of the Medfly in Guatemala using nonchemical tactics. The program would use a combination of nonchemical tactics to keep the Medfly at acceptable levels. Nonchemical pest management would be achieved through implementation of one of the following program options: (1) a nonchemical pest management barrier, (2) crop-specific pest management, or (3) a combination of the nonchemical pest management barrier and crop-specific pest management.

Option 1, the nonchemical barrier option, would attempt to keep the Medfly at 1988 levels in the Medfly-free and post-eradication zones. In other words, this is a barrier option similar to the Isthmus of Tehuantepec barrier alternative, except for use of pesticides. All uses of pesticides (both field and quarantine station uses) would be stopped and replaced with nonchemical methods. The methods would include: sterile Medfly releases; cultural controls; biological controls; nonchemical regulatory controls (stripping, confiscating, burning, or burying fruit); the prohibition of certain fruits for which treatment does not exist; and U.S. approved nonchemical postharvest treatment methods that may become available, such as hot water treatments. Rigorous monitoring (Medfly trapping and fruit sampling) would be conducted in support of this option.

Option 2, the crop-specific pest management option, would restrict the management effort to major non-coffee Medfly hosts with good commercial potential and high susceptibility to Medfly attack such as pear and peach. The objective would be to keep field infestations of Medfly to a minimum in these crops. The methods would include release of sterile Medflies, all available cultural controls, biological control agents, and all available nonchemical regulatory controls (stripping and confiscating and burning or burying fruit, and U.S. approved nonchemical post-harvest quarantine methods, e.g., hot water treatments). In addition, the Medfly monitoring procedures of option 1 would be used. Management of Medfly under option 2 would not attempt to contain the Medfly within Guatemala; Mexico would be required to use the sterile Medflies it produces to maintain its own barrier near the Isthmus of Tehuantepec rather than contribute them to the Guatemala MOSCAMED Program. Guatemala does not produce sufficient numbers of sterile Medflies to carry out a Guatemala-wide SIT control program on Medfly in coffee crops. However, Medfly losses to coffee are very low, so the bulk of sterile Medflies would be used against Medfly in the other crops (primarily pear and peach) and not coffee.

Option 3, the combination of a nonchemical barrier and crop-specific pest management, combines all features of the two component options. Implementation of this option would have as its objective the maintenance of a Medfly-free barrier and also protection of the major crops identified in option 2. The methods would include release of sterile Medflies, all available cultural controls, biological control agents, and all available nonchemical regulatory controls (stripping and confiscating and burning or burying fruit, and U.S. approved nonchemical postharvest quarantine methods, for example, hot water treatments, that may become available). In addition, rigorous monitoring (Medfly trapping and fruit sampling) would take place.

The nonchemical pest management alternative (including any of the three options) is unacceptable for a variety of reasons, including: (1) ample documentation of the ineffectiveness of the sole use of nonchemical methods to control and prevent the spread of Medfly infestations, (2) failure to meet Guatemalan eradication objectives, (3) increased risk of Medfly spread northward into Mexico and the United States because Medfly populations in coffee are allowed to go unchecked, and (4) difficulty and associated high costs of sustaining indefinitely a massive suppression program. Therefore, this alternative has been eliminated from further analysis.

V. Control Alternatives

A. Discussion and Analysis of Control Alternatives

1. No Action

The no action alternative would involve no cooperative effort on the part of APHIS and/or the Guatemala MOSCAMED Program to control the Medfly in Guatemala. In the absence of control efforts, the Medfly could spread into previously uninfested areas, occupy the Guatemalan territory from which it had been eradicated, and could reinvade the border regions of Mexico. Guatemalan crops that are host to Medfly or to other pests which are currently prohibited entry into the United States would remain prohibited, thereby blocking an avenue for expansion of the Guatemalan agricultural economy. Thus the no action alternative would result in significant economic losses to Guatemala as well as loss of potential agricultural markets.

In addition, significant increases in Medfly population in Guatemala would result in increased risk of spreading Medfly to Mexico and the United States. Additional expenses would be incurred for both the United States and Mexico because of the resultant increase of inspections, regulatory treatments, and probable need to eradicate Medfly outbreaks. The economic impact on Mexico if the Medfly became established there has been estimated at $254 million annually.

Each year Medfly host produce is illegally brought into the United States from counties where the Medfly is established. These illegal importations can lead and probably have led to isolated outbreaks or infestations of Medfly in the United States. The cost of eradicating such outbreaks in the United States can range from hundreds of thousands to tens of millions of dollars. The potential impact to the United States if Medfly were to become permanently established has been estimated at between $824-834 million annually (USDA, 1989).

Refer also to the no action program alternative discussed previously in this analysis, since no control action equates to no program action.

2. Sterile Insect Technique

a. Description and Application

The sterile insect technique (SIT) consists of mass rearing of Medflies, sterilizing them, and releasing them into areas where they mate with feral (wild) Medflies. Those matings produce only infertile eggs, and the feral population is destroyed through attrition. Even though sterilization of male Medflies may result in as much as a 40% reduction of competitive ability for mating as compared to feral males (Ohinata et al., 1978), flooding an area with large numbers of sterile Medflies greatly reduces the likelihood of normal fertile matings for the feral population. If the sterile insects are released often enough, and in sufficient numbers, the feral population will decline and eventually be eradicated.

Large numbers of Medflies are reared and sterilized (in the late pupal stage) with gamma rays (10 to 18 Krad) from a cesium-137, cobalt-60, or other irradiation source in nitrogen or reduced oxygen atmospheres (Ohinata et al., 1978). Although chemosterilants (Keiser et al., 1965) and heat (El-Gazzar, 1979) have been used in place of irradiation to achieve sterilization, the efficacy and consistency of results using irradiation have made it the method of choice in this program.

Following irradiation, the sterile pupae are packed into paper bags and held 3 days until 85-90% of the flies have emerged. The bags containing the sterile adults are then loaded into air-conditioned vehicles for transportation to the release aircraft. The sterile flies are released in numbers calculated based on detection data and the size of the release area.

SIT is most effective against low-level Medfly populations where high overflooding ratios (proportion of sterile to feral Medflies) are easier to achieve. Malathion bait spray is normally used to achieve this low-density requirement. SIT is effective when a ratio of at least 100:1 sterile male Medflies to feral male Medflies is sustained. Increasing the ratio above 100:1 improves the effectiveness of the SIT technique.

b. Effectiveness and Field Experience

SIT has been used for the past 30 years. A number of Medfly suppression programs have used SIT, including efforts in: Hawaii (Steiner et al., 1962); California (Cunningham et al., 1980); Florida (USDA-APHIS, 1985); Nicaragua (Rhode et al., 1971); Tunisia (Cheikh et al., 1975); and Italy (de Murtas et al., 1970). The use of SIT provided significant (90%) reductions of Medfly populations (Steiner et al., 1962; Rhode et al., 1971) or resulted in eradication (de Murtas et al., 1970; Cunningham et al., 1980), when wild populations were sufficiently low prior to initiating SIT treatment.

In combination with carefully coordinated malathion bait spray, SIT has been the principal tactic used in successful Medfly eradication efforts. MOSCAMED used the technique in combination with malathion bait spray to eradicate the Medfly from southern Mexico (Ortiz et al., 1987). The full-scale eradication program in Mexico began in 1977 and the Metapa de Dominguez (Mexico) Medfly rearing facility attained a production capacity of 500 million sterile Medflies per week in 1979. Mexico declared the Medfly eradicated from its territories in 1982.

The SIT technique alone was attempted for Medfly eradication in the fall of 1980, in Santa Clara County, California. There, sole reliance on SIT was unsuccessful because an insufficient number of sterile Medflies was available to maintain the necessary ratio of 100:1. As a result, the Medfly population and the infested area increased, requiring the use of alternative control measures, including malathion bait spray.

The sole reliance on SIT under the circumstances existing in Guatemala could result in the feral Medflies overwhelming the sterile Medfly population, with the ultimate result being the same as that expected for the no action alternative. Sterile Medfly availability is limited by the continuity and capacity of the rearing facilities in Mexico and Guatemala. The continuing presence of infested fruit and active breeding populations of feral Medflies during the period of treatment may present an unacceptable risk of movement of infested commodities to other areas of Guatemala and Mexico which could become reinfested as well. The extent and magnitude of the current infestation in Guatemala portends that there are not sufficient sterile Medflies available to assure eradication solely using this technique.

Even with ample sterile Medfly availability, there is no assurance this technique alone can eradicate an infestation as large as the infestation in Guatemala. During the release period, the Medfly pressure may present an unacceptable risk of movement of infested commodities to other areas of Guatemala and Mexico which could then become infested or reinfested as well.

SIT is most effective when used in conjunction with chemical treatments that reduce the ratio of feral to sterile Medflies, thus ensuring the efficacy of the sterile releases. SIT has been used following aerial strip treatments in Guatemala and has been used in treatments timed with the natural reduction in the native population. The combination of SIT with malathion bait spray has proven successful in eradication of Medfly populations in Mexico and Guatemala.

c. Rearing Facilities

Sterile Medflies used in the Guatemala MOSCAMED Program are produced at the program's rearing facilities in San Miguel Petapa, Guatemala, and Metapa de Dominguez, Mexico. The Medfly eggs are collected from the facilities' brood or reproductive colonies and placed in a diet medium containing protein hydrolysate (yeast), sugar, wheat, bran, bagasse (crushed processed sugar beets or sugar cane), water, and microbial inhibitors. Medfly larvae develop in the diet and are separated from it when mature. The pupae are irradiated 2 days prior to adult emergence and placed in paper bags (14,000 to 16,000 pupae/bag) where the adults emerge. The irradiation dosage is approximately 14.5 krad. This dosage level ensures the sterility of all female Medflies released (Ohinata et al., 1977). Approximately 99.5% of the male pupae irradiated at 15 krad are sterile (Ohinata et al., 1978). Pupae are held in paper bags for approximately 72 hours or until 85 to 90% emergence has occurred. The adults, both male and female, are held in the bags for 24 to 48 hours at approximately 14°C before ground or aircraft release. For additional details on the rearing procedures, consult appendix 5, Cooperative Agreement #12-16-86-044.

The rearing facility in Guatemala has produced an average of about 200 million sterile Medflies per week; however, maximum rearing capacity is about 325 million sterile Medflies per week. Average rearing capacity of the facility in Mexico is approximately 450 million per week; maximum capacity of this facility is about 700 million per week.

Insect disease outbreaks from contamination of implements, equipment, or water traditionally create problems in insect rearing facilities. Both the Guatemalan and Mexican rearing facilities have experienced similar problems in the past 4 years. Better sanitary practices and use of filtered water have significantly reduced the problem of disease; however, disease still has the potential to reduce sterile Medfly production by 10%. Both facilities continuously monitor microbial levels to reduce losses attributable to contamination. Procedures for identifying the causative organisms and eliminating disease outbreaks are standard.

d. Limitations

Medfly SIT is species specific, that is, it acts only against the Medfly. Therefore, it affords a means for achieving ecological selectivity in a control tactic. For this method to be effective, a minimum ratio of 100:1 sterile males to feral males is required. Due to the quantity of Medflies which would need to be released to counteract a large infestation, some other method (usually malathion bait spray) is needed to reduce the pest population initially.

3. Chemical Control

Malathion bait spray is a mixture of a toxicant (malathion) and a bait (protein hydrolysate, e.g., Nu-lure®). The bait acts as a Medfly attractant and feeding stimulant (Hagen, 1953). Bait spray containing the toxicant is used to reduce wild Medfly populations to a level where sterile Medflies can be effective. The bait spray attracts and destroys both male and female adult Medflies.

Malathion bait spray is dispensed by aircraft or by ground applicators using backpack sprayers. It may also be applied in bait stations using corncobs ("olotes"). The following procedures have been used and are standard alternatives in the Guatemala MOSCAMED Program:

a. Aerial Full Coverage With Malathion Protein Bait

Aerial applications will be made with an ultra low volume (ULV) formulation of malathion protein bait consisting of a mixture of 1 part malathion (91 to 95%) to 9 parts protein hydrolysate bait (Nu-lure®). Nu-lure® acts both as an attractant and a feeding stimulant. Approximately 1 liter of formulation per hectare is used, corresponding to 111.8 grams active ingredient (a.i.) of malathion per hectare (approximately 1.52 oz a.i. per acre). In comparison with most other malathion uses, these rates are exceedingly low, thereby contributing to a lack of adverse environmental effect.

Applications are made with fixed-wing and/or rotary-wing aircraft, preferably between the hours of 6:00 a.m. and 11:00 a.m., when wind conditions are calmest. Program mitigation procedures require that the wind velocity not exceed 10 mph at the time of aerial application. The pesticide is discharged from the aircraft spray apparatus in large droplets, approximately 1 to 3 mm in diameter. The full-coverage method consists of application in contiguous strips or swaths throughout the area being treated. Application altitudes are 70 to 80 meters for fixed-wing aircraft and 25 to 35 meters for rotary-wing aircraft. Swath widths are approximately 100 meters for fixed-wing aircraft and 50 meters for rotary-wing aircraft. Flight lines of application aircraft are marked with aerial markers (kytoons) and the applications are monitored by ground observers using dye cards for evaluation of droplet size, swath width, and drift.

Thorough coverage of host tree foliage with malathion bait spray reduces adult populations by 90 to 100%, immediately reducing reproduction by gravid female Medflies. This not only provides a direct decrease of the next generation, but also reduces risk of gravid female Medfly migration into surrounding uninfested areas.

Limitations of this method include the high cost of application (as compared to aerial strip coverage with the same material) and lack of an untreated buffer zone for nontarget organisms, including beneficials, which may be subject to effects of the pesticide.

b. Aerial Strip Coverage With Malathion Protein Bait

Aerial strip coverage with malathion protein bait uses the same equipment, formulation, and application rate as the full-coverage method, but the material is applied in alternating strips or swaths (one strip receives pesticide and the next strip is skipped) so that only one half of the total area is treated. The widths of the strips correspond to the swath width for the type of aircraft used—approximately 100 meters for fixed-wing aircraft and 50 meters for rotary-winged aircraft.

This technique is intended to suppress rather than eradicate the population. Suppression achieved through a succession of treatments at weekly intervals prepares the area for effective use of the sterile insect technique (SIT). SIT begins following cessation of aerial strip coverage. The number of bait spray applications and the density of sterile flies released is based on survey results, host availability, climate data, and proximity to sensitive areas.

This method affords a greater degree of protection to nontarget organisms in "safe zones," or strips which are not sprayed. Compared to full-coverage aerial application, this alternative is accomplished more rapidly, at less cost, and in most cases with less insecticide used.

A disadvantage of this technique is its reduced effectiveness as compared to aerial full-coverage treatment with malathion protein bait; the use of aerial strip spraying may permit enough survival and reproduction of Medfly between the strip-sprayed areas to prolong existing infestations.

c. Ground Full-Foliar Coverage With Malathion Protein Bait

Ground full-foliar coverage applications will be made with malathion protein bait consisting of 1 part malathion (57% emulsifiable concentrate), 3 parts Nu-lure®, and 96 parts water. Approximate application rate is 30 liters of formulation per hectare, corresponding to 171 grams a.i. of malathion per hectare.

Ground applications are made with manually pumped backpack sprayers. Each backpack sprayer has a total capacity of 12 liters, but is filled with 10 liters of malathion bait formulation. Personnel using the sprayers are organized into groups called "brigades" that are staffed by individuals trained in pesticide formulation and application, cartography, and first aid. Ground applications are made on larger coffee plantations during the wet season when aircraft cannot be used and to reduce Medfly outbreaks (all seasons) in the Medfly-free and post-eradication zones. Ground spraying is the primary method for dispensing bait spray on small farms and around villages and towns.

Coffee plantations are treated with approximately three backpack loads (30 liters) of formulation per hectare. For established commercial fruit orchards, applications are done in alternate rows, or by spraying alternate trees in each row. If the trees are dispersed, each host tree in the area is treated.

Generally, the hosts are treated in an area expanding outwardly from a Medfly detection, until there are no more hosts; this greatly reduces potential for spread. The Guatemala MOSCAMED Program's policy is to treat all Medfly host plants found within 1 km^2 of a Medfly infestation area.

d. Ground Spot Coverage With Malathion Protein Bait

Ground spot coverage with malathion protein bait uses the same equipment, formulation, and application rate as the ground full-foliar coverage method. However, with ground spot coverage treatment, the spray is applied only to about 25% of a plant's foliage area.

Compared to ground full-coverage application, this alternative is accomplished more rapidly, at less cost, and in most cases with less insecticide used. It also affords a somewhat greater degree of protection to beneficial organisms.

e. Bait Stations—"Olotes"

The bait station treatment uses corncobs saturated with 1 part of 95% malathion and 7 parts bait (Nu-lure®). Individual bait stations, called "olotes," consist of the saturated corncob, a cotton wick wired above containing a chemical attractant (the synthetic para-pheromone Trimedlure®), and a waxed cardboard roof. They are placed high enough in host trees to be out of reach to the general public.

The olotes are used in urban areas, ecologically sensitive areas (e.g., near apiaries, parks, or lakes), and in coffee plantations. Olotes are also used during the rainy season when aerial applications of malathion bait are not feasible. The Guatemala MOSCAMED Program uses about 3,000 olotes at any one time: 1 per hectare in coffee plantations and up to 5 per hectare in urban areas.

4. Cultural Control

Cultural control reduces insect populations through the variation of agricultural practices. Put another way, cultural control manipulates agricultural practices to make the crop environment as unfavorable as possible for insect pests. Generally, cultural controls are often used when chemical or biological methods have not been successful in combating a new pest species. These control methods may include: crop rotation, varying planting locations, trap cropping, modified tillage practices, clean culture, special timing, use of resistant varieties, and manipulation of alternate hosts.

Although cultural controls may present fewer potential adverse environmental effects, they may be of limited usefulness in broad control programs over extensive areas. Many cultural controls are labor intensive. They also may not provide the degree of control required to bring rapid economic relief from Medfly infestations, or to avoid restrictive regulatory measures. Acceptance of cultural controls by growers also may be a factor in their selection.

A number of cultural control methods have applicability for control of Medfly. Because of its limited effectiveness when used exclusively, cultural control's greatest value against Medfly in Guatemala is as a complementary method. This section identifies and briefly discusses potential cultural controls for Medfly in Guatemala.

a. Clean Culture

Careful and complete harvesting, combined with destruction of infested and unmarketable Medfly host crops, is important in reducing Medfly populations. In Hawaii, removal of Kona coffee beans that remain on the plants after harvest in January and February helps prevent Medfly population increases.

Sanitation measures, including farmers' practices of collecting and burying host fruit left after harvest, destroying damaged fruit, and removing unwanted or wild alternate hosts in and around fields, are often recommended for suppressing Medfly infestations. The collection and destruction of Medfly host fruit destroys the eggs and larvae developing in the fruit and limits the availablity of fruit for further Medfly reproduction. On the basis of demographic studies with an established population of the Medfly, more than 30% and more than 49% of the pest are in the egg and larval stages, respectively (Carey, 1984) This technique does not destroy or prevent dispersion of adults which are already present and does not affect the number of Medfly emerging from pupae already in the ground. Thus, fruit stripping has value as a suppressive technique or a technique contributing to eradication, but sole reliance on this method would not result in eradication. The logistical aspects of collecting and disposing of the fruit limit its operational use.

When fruit stripping actions are necessary, the Guatemala MOSCAMED Program will purchase certain fruit (caimito, coffee, guava, and tangerine) when economically feasible for destruction in a manner approved by Guatemala: incineration, burial, or a combination of the two at an approved landfill or refuse site. The destroyed fruit is required to be covered with at least 45.7 cm (18 in) of soil. Field sanitation may be of limited effectiveness for reducing Medfly in Guatemalan coffee because of the long and variable harvest period, and large numbers of Medfly host plants or fruit in a given location.

b. Special Timing

In some geographical regions, Medfly populations could be reduced by scheduling the planting of short-season fruit and vegetable crops so that fruit ripening does not coincide with peak Medfly activity, or by harvesting the fruit before it reaches a stage of ripeness highly susceptible to Medfly attack. Although this technique theoretically could reduce Medfly populations, it is not likely that enough control could be exercised over commercial agricultural practices to make it effective or worthwhile. The long growing seasons and continuous availability of host material in tropical regions limits the use of this technique.

c. Trap Crops

Trap cropping involves the planting of a crop that is favored by the pest in order to attract and concentrate the pest in a limited area where it can be destroyed by chemical or cultural methods. For other insect pests, trap cropping often involves planting a small plot of the favored host crop prior to the main crop so that overwintered life stages of the pest will be concentrated and destroyed by pesticides or by plowing the crop under before the main crop is infested. This method probably has limited usefulness in Guatemala due to the perennial nature and abundance of host crops (coffee, orange, grapefruit, mango, etc.).

d. Resistant Varieties

Reductions in Medfly populations could also be achieved through a public information program to illustrate the value of and recommend the selection of crop varieties that are non-hosts or partially resistant to the Medfly. Mechanisms that may serve as a basis for host plant resistance to the Medfly have been demonstrated in some of its host crops (Greany et al., 1983; Eskafi, 1988).

5. Regulatory Control

a. Quarantine

Quarantine programs are used to reduce the likelihood of transporting Medfly into Medfly-free areas and are an important element of any eradication or pest management strategy. The legal authority to restrict both internal and external movement of agricultural commodities is vested in the Government of Guatemala. The regulatory actions (inspection, treatment, and confiscation) are enforced by the Guatemalan Ministry of Agriculture, Livestock and Food. Since the regulatory actions taken to prevent Medfly dissemination and resulting economic loss are under the authority of the Government of Guatemala and not directly under the control of the Guatemala MOSCAMED Program, those regulatory actions are described but not subjected to detailed analysis within this document. Additionally, it should be noted that the Guatemala MOSCAMED Program has proposed to OIRSA that the regulatory effort be managed by that independent authority.

Quarantine stations would be maintained at 21 locations in Guatemala: along motor vehicle routes, at the Guatemala City International Airport, at the Peten and Poptun Airports, and at the water port at El Estor, Lake Izabal. Four principal control activities will be managed at internal quarantine stations: (1) vehicles will be inspected for the presence of host material; (2) vehicles may be treated with d-phenothrin to kill adult Medfly; (3) host materials will be confiscated and buried or burned; and (4) commercial host materials will be treated and certified as necessary at eight of the quarantine stations before continuing into Medfly-free areas. In addition, there will be quarantine facilities at 12 points along Guatemala's international boundaries.

Guatemala City is in an area currently infested with Medfly. Therefore, airplanes arriving in Guatemala from other Medfly infested areas are not presently inspected for Medflies or subject to quarantine treatment. However, airplanes departing Guatemala City for Peten or Poptun (both in Medfly-free areas) will be inspected for Medfly and subject to quarantine treatment. As a further precaution, the Peten and Poptun airports have quarantine inspection and treatment programs to eliminate Medflies on arriving aircraft. Boats embarking and disembarking at El Estor are also subject to quarantine inspection and treatment.

b. Pesticide Use in Quarantines

1. Treatment of Conveyances

Vehicles passing through quarantine stations may be treated with a 2% solution of d-phenothrin when found to contain Medfly host material. Previous uses of the insecticides dichlorvos and propoxur have been discontinued for this purpose. D-Phenothrin is an aerosol insecticide with a very low mammalian toxicity (oral LD_{50} 10,000 mg/kg, percutaneous LD_{50} 10,000 mg/kg), yet it is quite effective for fruit flies and other soft-bodied insects (Hartley and Kidd, 1987). As stated previously, regulatory treatments are under authority of the Government of Guatemala and not the Guatemala MOSCAMED Program and are excluded from further analysis.

2. Fumigation of Agricultural Commodities

APHIS has developed procedures for using methyl bromide (MB) for treatment of known Medfly host commodities in Guatemala. These treatments are not approved for Guatemalan fruits, vegetables, or other food commodities intended for export to the United States. The primary reason for the lack of approval is the treatment's failure to meet United States quarantine security requirements.

3. Treatment of Exports

As noted, the United States will not accept Guatemalan fruit fumigated with MB due to quarantine security requirements. Potential alternative treatments to MB include gamma irradiation, vapor heat, and hot water treatments.

Gamma irradiation will prevent emergence of adult Medflies from some Medfly-infested fruits and vegetables (Moy et al., 1983). Pupae are harder to kill than eggs and larvae and require higher dosages (Burditt and Seo, 1971; Seo et al., 1973). One limitation of the gamma irradiation technique is that it may cause cosmetic damage, modify texture, or distort the color or flavor of some fruits.

Another technique, elevating the temperature to 43°C and increasing the humidity to saturated conditions for a period of 8¾ hours will kill immature Medfly in some fruits. Similarly, lowering the temperature and humidity (for 16 hours or more) will kill the immature forms in some fruits (Instituto Interamericano de Cooperacion para la Agricultura, undated). A hot water dip has proven efficacious for some fruits, and may be considered for Guatemalan exports.

Neither gamma irradiation nor the temperature treatment is practical when large quantities (or certain kinds) of fruit must be treated due to special chamber and equipment requirements. The use of these or any treatment measures for fruit imported into the United States is subject to approval by the USDA.

4. Fruit Destruction

Stripping and destroying Medfly infested or Medfly susceptible fruits are especially important during quarantine periods when spot infestations are detected. Fruit stripping has been an integral part of the Medfly eradication effort in Guatemala. The practice has been to strip and bury all Medfly susceptible fruit found within 1 km^2 of a Medfly infestation (as delimited by trapping or fruit sampling) in the Medfly-free or post-eradication zones (Comision MOSCAMED Document MM. No. 47; undated, Anonymous).

6. Integrated Control (Preferred Control Alternative)

Integrated control is the preferred control alternative of the Guatemala MOSCAMED Program. Integrated control is defined as the selection, integration, and implementation of pest control tactics in a systems approach on the basis of anticipated economic, ecological, and sociological consequences. Under integrated control, the selection of a particular control method or combination of methods for an individual site would take into consideration several factors, including economic (the cost and the cost effectiveness of various methods in both the short and long term), ecological (the impact on nontarget organisms and the environment), and sociological (the acceptability of various integrated control methods to cooperators, or the potential effects on land use).

In the Guatemala MOSCAMED Program, integrated control would use singly, or in combination, any of the following component control methods in the eradication effort: sterile insect technique (SIT), chemical control, cultural control, and regulatory control. Each of these control methods is considered in detail in its own section of this analysis. Integrated control was selected as the preferred control alternative for this program because it offers the combination of maximum environmental protection with program efficacy.

Integrated control can be functionally identical to integrated pest management (IPM), a widely favored pest control alternative, but differ notably with regard to its objective. Integrated control is frequently used for eradication programs when the objective is to eliminate entirely the target pest rather than merely suppress it. IPM, as its name implies, is used in programs where the objective is to "manage" a pest or suppress its populations below levels that are capable of producing economically significant crop damage. IPM cannot be viewed as a realistic alternative in controlling Medfly in Guatemala due to the Government of Guatemala's objective of eradicating the Medfly, the lack of protection a suppression program would afford to Mexico and the United States, and the continual need for control efforts with corresponding potential for environmental impact. An IPM approach also would not satisfy the quarantine concerns of many potential fruit importing countries for which the mere presence of the pest in Guatemala would be the basis for sanctions such as import prohibitions of Guatemalan produce .

It is generally accepted that IPM is an approach that employs a combination of techniques to control the wide variety of potential pests that may threaten crops. It is not simply biological control or the use of any single technique. Unfortunately many misunderstand the practice of IPM and confuse it with organic gardening, a method that does not use synthetic chemicals. The purpose of IPM is not to avoid the use of chemicals, but to use the most effective or environmentally sound pest control technique or combination of techniques for long-range pest control (CEQ, 1972).

Although the Guatemala MOSCAMED Program relies upon the use of malathion bait spray in close coordination with the sterile insect technique (SIT), other nonchemical alternatives such as cultural controls and fruit stripping are necessary and effective adjuncts of the program. The Guatemala MOSCAMED Program developed protection measures and mitigative measures to protect sensitive areas, endangered and threatened species, and other components of Guatemala's environment. The program constraints that arise as consequences of adhering to those specific protection measures require the analysis of available control alternatives and their selection based on site-specific considerations. Provided that the potential environmental effects of the integrated control components have been analyzed and that any necessary protective measures are employed, then maximum flexibility can be afforded the program manager for the selection of alternatives to fit the situation.

B. Control Alternatives Considered and Eliminated

1. Biological Control

Biological control is the reduction of pest populations through the action of living organisms in a process assisted by human intervention. It differs from natural control primarily in that human intervention is involved. Medfly populations are influenced by the interaction of various predators, parasitoids, and pathogens. These biological agents may be significant in the natural regulation of Medfly populations.

Theoretically, natural enemies of the Medfly could be used to replace, or at least reduce dependency of, malathion in Medfly control efforts. However, the effectiveness of natural enemies does not ensure their successful employment as biological control agents; the complex ecological relationships and difficulties encountered in attempts to augment the populations of such species often limit their effectiveness in biological control programs. Although many organisms show a great deal of promise, much more research and development (especially in targeting efficacy, rearing, and potential impacts) are needed before biological control technology of Medfly can be exploited.

Although biological control is not an operationally viable control alternative for use in Guatemala at this time, this section identifies and briefly discusses natural enemies which may have potential for future Medfly control.

a. Parasites

Parasites of the Medfly include nematodes, which are small (often microscopic) unsegmented roundworms with cylindrical, elongate bodies. The potential for using entomophagous nematodes as biological control agents has been investigated for many years. Numerous factors affect their potential utilization as biocontrol agents, including: efficacy, host range, behavior, habitat requirements, and potential conflicts with other biocontrol organisms. As with predators, there has been little done to demonstrate the practical effectiveness of using nematodes as biocontrol agents in a large-scale field program such as the Guatemala MOSCAMED Program. Although most species of entomophagous nematodes that have been studied extensively with regard to their biocontrol potential have a worldwide distribution, further research is required relative to their effects on beneficial and other nontarget soil insects or organisms before they can be considered for use in a widescale eradication program.

One of the more widely studied species of entomopathogenic nematodes, *Steinernema feltiae*, has a wide host range, including *Scolytus scolytus* (a bark beetle), *Spodoptera exigua* (the beet armyworm), *Diaprepes* *abbreviatus* (a coleopteran citrus pest), and several species of tephritid fruit flies. Infected adult insects are able to transmit the nematodes for some distance until the insect is within one-half hour of death (Timper, et al., 1988). Studies of *S. feltiae* have shown that, when applied to the soil in Medfly habitats, it can infect and kill Medfly larvae, and to a lesser extent, emerging adults, but not pupae (Lindegren and Vail, 1986). An interesting relationship which has been noted by researchers involves the presence within the nematode families of Steinernematidae and Heterorhabditidae of symbiotic bacteria which are pathogenic to insects (Poinar, 1983).

Some nematode species are hermaphroditic (male and female organs on the same individuals) and are capable of self-fertilization and subsequent reproduction within an insect host. Other species have separate sexes, and for an entomophagous infection to occur, both a male and female must enter the same host. If an infection occurs within a newly-emerged adult insect, the infection can be spread by the adult to insects in other areas (Timper et al., 1988). Due in part to dispersion by infected insects and due to the wide range of those insects, many entomophagous nematode species such as *S. feltiae* have worldwide distribution.

Under laboratory conditions involving direct contact between the Caribbean fruit fly, *Anastrepha suspensa*, and *S. feltiae* or *Heterorhabditis heliothidis*, neither of the two nematodes showed a significant advantage in infectivity at the same application rate (Beavers and Calkins, 1984). In soil, an application rate for *S. feltiae* of 500 per cm^2 resulted in a mean larval mortality of 87.1% for Medfly (Lindegren et al., 1990). However, under field conditions, *S. feltiae* requires a population density approximately five times greater than that of *H. heliothidis* to produce the same level of entomophagous infection (Choo et al., 1989). These differences may be due to differences in reproductive biology and mobility, both of which relate to infectivity (Georgis and Poinar, 1983). Others have concluded that *S. feltiae* may not be the best nematode species for use as a biocontrol agent and that other species of entomophagous nematodes should be screened for their effectiveness on insect host species.

Entomophagous nematodes being considered for use in pest control or pest eradication programs should be considered with respect to their compatibility (or noncompatibility) with other naturally occurring biological controls. In some instances, insect parasitoids could be in competition with the nematodes for the use of host tissues (Mracek and Spitzer, 1983).

b. Parasitoids

Parasitoids are organisms that live in or on the body of another organism (the host) and that consume most or all of the host's tissues, eventually killing it. Many of the insect parasitoids belong to the insect order Hymenoptera, which includes bees, ants, and wasps.

A complex of insect parasitoids probably comprises the most important naturally occurring biological control agents for the Medfly throughout the world. These organisms attack Medfly eggs, larvae, and pupae, achieving fairly high levels of parasitism. Overall parasitism of immature forms of Medfly collected from all hosts at Maui, Hawaii, was 40%; the rate was highest in Medflies attacking peaches (60%). Of parasitoids recovered, 80% were *Biosteres oophilus* (Wong et al., 1984a). Percent parasitism was relatively constant despite large fluctuations in the quantity of host materials in the populations of Medflies and parasitoids.

The Medfly is heavily parasitized in Africa, wherever it is found (Le Pelley, 1968). When the Medfly was first discovered in Costa Rica, a number of parasitoids were introduced against it: *Trybliographa daci*, *Aceratoneuromyia indica*, *Dirhinus giffardi*, *Pachycrepoideus vindemiae*, *Biosteres oophilus*, *B. tryoni*, *B. vandenboschi*, *B. formosanus*, *B. compensans*, *Diachasmorpha* (=*Biosteres*) *longicaudatus*, *B. l. novocaledonicus*, *B. l. thaiensis*, *B. l. malaiensis*, *Opius concolor*, and *O. incisi*. In addition, native species like *Dorytobracon crawfordi*, *D. cereus*, and *Ganaspis carvalhoi* parasitized the pest (Morales, 1984).

Releases of parasitoids also have been made to control the Medfly in El Salvador, Panama, and Nicaragua. Of the species introduced into Central America, apparently only *D. longicaudatus* (in Costa Rica and El Salvador) and *A. indica* and *P. vindemiae* (in Costa Rica) have become established. *Pachycrepoideus vindemiae* is apparently widely distributed throughout Central America (Mitchell et al., 1977).

The impact of introduced natural enemies has been studied more in Costa Rica than in other Central American country. In Costa Rica, in 1971-72, parasitism by *D. longicaudatus* ranged from 8 to 30% and by *P. vindemiae* from 2 to 14%. The highest total parasitism was 35% in 1971-72 and 60.2% in 1974 (Mitchell et al., 1977).

Studies that relate rates of parasitism to levels of Medfly infestation in different host plants are lacking. This data would be useful in determining the effectiveness of parasitoids in suppression or control of the Medfly.

The models (Knipling, 1979) suggest that inundative releases of parasitoids (colonization and liberation of large numbers) to reduce Medfly abundance prior to release of sterile flies may have promise. The production of Medfly parasitoids for release in the field has been accomplished (Chong, 1962; Gonzalez, 1981; Finney, 1953; Harris and Okamoto, 1983).

c. Predators

Predators are animals that attack and feed on other animals, usually smaller and weaker than themselves. Some researchers have investigated predators' foraging habits in relation to Medfly as prey. Although there may be biocontrol potential for some of the predators, very little work has been done in relation to practical exploitation of these organisms and none can be recommended as part of an available biocontrol strategy at this time.

Predation by ants on Medfly larvae has been observed when third instar Medfly larvae drop from infested fruit to the ground where they burrow into the soil and pupate. The fire ant, (*Solenopsis geminata*), was found to be a predator of Medfly in Costa Rica (Morales, 1984) and in Guatemala (Eskafi and Kolbe, 1990). It has been estimated that in Hawaii, predation by the Argentine ant, *Iridomyrmex humilis*, caused about 3% mortality in Medfly larvae and 39% mortality in Medfly pupae and new (teneral) adults (Wong et al, 1984b). *Pheidole megacephala* was reported preying on Medfly larvae (Steyn, 1955).

Under field conditions in Guatemala, predators killed 47% of the Medfly pupae in coffee orchards and 34% of the Medfly pupae in citrus orchards (Eskafi and Kolbe, 1990). They attributed most of this predation to staphelinid beetles which were found in large numbers in both orchards.

In Egypt, praying mantids had a success rate of 1 capture per 12 ambushes on Medfly adults, increasing to 1 in 4 during the period when the Medflies oviposited (Hendrichs and Hendrichs, 1990). Libellulid dragonflies preyed on Medflies when they were entering and exiting the canopy of the tree, while damselflies and vespid wasps searched fruit and the underside of leaves. The temporal and spatial dispersion by the Medflies was paralleled by that of their predators.

Other predators such as spiders and birds readily feed on Medflies.

d. Symbionts

Symbionts are different organisms that live in a close associations that may but do not necessarily benefit each other. Bacteria and other micro-organisms within individual Medflies play essential roles in nutrition and symbiotic physiology. Copper carbonate interferes with the Medfly's symbiotic intestinal flora, thereby having a toxic effect on the pest. A copper and sugar mixture (copper sucrate) showed promise against the Medfly (Christenson and Foote, 1960), but the technique has not been shown to be feasible in an eradication program. The potential technique's apparent toxicity to Medfly seems to conflict with reports that copper-based compounds used for control of coffee rust in Guatemala have not appreciably reduced Medfly populations there.

e. Pathogens

The causative agents of disease (frequently microorganisms such as viruses, bacteria, and fungi) are called pathogens. Two viruses were reported in the Medfly (Plus and Cavallora, 1983): a reovirus (called I) and a picornavirus (called V). Medfly was found to be a permissive host for two *Drosophila* viruses: Rhabdovirus Sigma and Picornavirus C (DCV). Although very little is known about these viruses, reoviruses are usually only mildly pathogenic in insects.

Bacillus thuringiensis (Bt) is a bacterial pathogen of insects which has been used against a number of pests including various species of moths, beetles, and mosquitoes. Strains of Bt are currently being screened for toxic isolates which might be effective against the Medfly. If a highly effective and environmentally acceptable strain is found, then a mixture of Bt and protein hydrolysate bait could be researched as an alternative for malathion bait spray. When a total of 94 Bt isolates and sucrose/dry yeast hydrolysate were fed to Medflies over a 7 day period, 15 out of the 94 isolates caused 80% or greater mortality among adult Medflies within 9 days (Gingrich, 1987). The research with Bt is still considered in the preliminary phase.

Protein hydrolysate could serve as a potential carrier for biocontrol pathogens. However, it is acidic and may be incompatible with many pathogens.

The USDA Agricultural Research Facility at Ithaca, New York, maintains approximately 3,000 isolates of fungal isolates in stockpile (personal communication with Raymond Carruthers, December 17, 1990). Entomopathogenic varieties of these are currently being screened to determine the relative effectiveness against Medfly. As with Bt, these may have potential for integration into protein hydrolysate bait formulations. This research is also considered in the preliminary phase, and no immediate application of the research is expected within the near future (personal communication with S.B. Krasnoff, December 28, 1990).

2. Other Chemical Controls

Considerable testing of various insecticides for efficacy against Medfly has occurred over the last 30 years. Many of the chemicals tested were either not effective in controlling Medfly or resulted in significant adverse risk to the environment when properly applied at application rates which effectively controlled this species.

Since 1952 several hundred insecticides have been assayed in the laboratory by topical application to the thoracic mesonotum of Medflies to determine toxicity at the Hawaiian Fruit Flies Laboratory (Keiser et al., 1973). Comparisons of toxicity of insecticides to Medfly have shown several compounds to be effective control agents (Keiser et al., 1973; Keiser and Tomikawa, 1970). The median lethal dose (LD_{50}) in these studies varied from 0.0010 microgram per fly for phenthoate to 2.5 micrograms per fly for American Cyanamid 12415. Malathion was shown to have an LD_{50} of 0.0073-0.0076. Dimethoate and naled were among the most toxic compounds to fruit flies.

Field studies involved the application of 37 insecticides as foliar sprays against Medfly (Keiser, 1968). Residual effectiveness was shown for persistent pesticides such as DDT, but rainfall rapidly decreased toxicity to less persistent insecticides such as malathion. Foliar spraying may provide adequate control of Medfly for short periods of time in given locations, but this will not prevent reinfestation from adjacent properties after the residual effectiveness is lost. Multiple applications at the higher rates for contact insecticide would be required for control over a full growing season. Standard control practice has been to use bait sprays which involve lower application rates. The bait attracts Medfly in the treated area and the surrounding environs. The bait is not attractive to many beneficial insects and the natural predators and parasites of Medfly would be affected less by this technique than by contact insecticide applications.

Chemical soil treatments with fenthion and diazinon were used effectively against Medfly in the 1980-82 eradication program in California. This technique consists of the application of insecticide to the soil surface around Medfly host plants. The insecticide kills Medfly larvae crawling on the soil surface or burrowing in the soil to pupate, and Medfly adults emerging from the soil after pupation. A number of chemical treatments were evaluated in the field against the Medfly in Kula, Hawaii (Saul et al., 1983). When tested in a peach orchard, diazinon reduced the populations 90% to 99%, depending on the dose and timing. This treatment is effective for small-scale eradication efforts, but operationally impractical and potentially environmentally unsound for a large-scale program such as this. It is also not a politically acceptable option for use in Guatemala.

The Hawaiian Fruit Flies Laboratory has tested various insecticides in bait sprays since 1950. Much of the early work was conducted by Steiner (Steiner, 1952; Steiner, 1955). Careful review of the control effectiveness and environmental considerations indicated that malathion bait spray was preferred over other insecticide bait sprays tested (Steiner et al., 1958).

The attractants used in bait sprays have also been investigated thoroughly at the USDA Agricultural Research Service (ARS) laboratories in Hawaii and Mexico. ARS investigations have screened approximately 13,000 compounds for better attractants (Chambers, 1990). Several test compounds proved to be more effective for males than females. Protein hydrolysate was shown to be the most effective attractant in malathion bait spray. The protein hydrolysate acts as a feeding stimulant that furnishes nutrients necessary for sexual maturation (Hagen, 1953). The bait spray attracts and kills both male and female flies. This reduces the number of progeny that can subsequently develop (Steiner et al., 1961). Other effective attractants used in Medfly traps for surveillance (e.g., Trimedlure®) have not proven effective for use in bait spray applications. The effectiveness of attractants in traps can be strongly affected by the trap design (Nakagawa et al., 1971; Nakagawa et al., 1975; Leonhardt et al., 1989) and the insecticide used (Hill, 1986).

ARS currently is investigating the use of Ceralure® as an attractant for male Medflies (Wood, 1989). Ceralure® is being evaluated for use in trapping and as a male annihilation technique. The male annihilation technique reduces the population directly by killing or trapping male flies attracted to the lure. Male annihilation has not been effective for Medfly in the past because the adults did not readily feed on the lures, the effective range was too small, and the residual effectiveness of the lures was relatively short (Cunningham et al., 1970). Ceralure® has been shown to last at least twice as long as the most widely used lure (Trimedlure®). The male annihilation technique is currently inadequate for use against

Medfly, but it may be a future option if field tests with Ceralure® can confirm its effective and economical use.

Boric acid, also known as boracic acid, is an inorganic boron compound. It is used as a fungicide, an herbicide, and an insecticide. In the United States, the Environmental Protection Agency (EPA) has registered the compound for use in control of indoor insect pests such as cockroaches, silverfish, and ants. It is not registered for use against any outdoor pests.

Since boric acid has not been registered for use outdoors, there is little information about its impact on nontarget organisms. It is very stable. If undisturbed in dry environments it can persist for long periods.

Boric acid will not be used in the Guatemala MOSCAMED Program and is eliminated from further consideration due to: (1) its lack of appropriate product labeling for use against Medfly; (2) its potential toxicity to nontarget organisms, and (3) its unproven efficacy in the field against Medfly.

3. Genetic Manipulation

Genetic manipulation involves the use of genetically altered insects whose sperm carries genes that make the wild populations less vigorous, less prolific, or genetically sterile. Genetic research on fruit flies has centered on sex ratio distortions, translocation homozygotes, conditional lethal genes, and isochromosomes. None of these tactics has yet reached the stage of practical implementation, and most are in an early stage of research.

The so-called "combi-fly" concept proposes the use of a stock carrying a male (Y-chromosome)-linked three chromosome, double translocation with a degree of inherited sterility of up to 75%. In Medflies such translocations have been isolated, produced, do not cause logistic problems in mass rearing, and are inherited by all male progeny. A combination of induced and inherited sterility could be produced by irradiating these flies with a substerilizing dose (e.g., 4 krad). Presumed advantages would be:
(1) a residual effect would result because the sterility is inheritable;
(2) combi-flies exhibit better field performance and competitiveness than sterile Medflies do; and (3) the degree of induced sterility can be varied to meet the needs of the program (Steffens, 1982; Steffens, 1983). The approach has not been field tested on the Medfly.

Genetic manipulation has been eliminated from further analysis due primarily to unproven efficacy against Medfly.

4. Host Elimination

Host elimination involves destruction of wild hosts (not cultivated plants) of the Medfly. The technique is not often used because of the difficulty in accessing and removing all wild hosts which are often in rugged terrain (Takara et al., 1983), and because of potential adverse environmental effect.

C. Medfly Population Monitoring

Monitoring of Medfly populations is an essential aspect of any Medfly control effort. Field monitoring will utilize two complementary methods to detect and/or estimate Medfly populations: the Jackson survey trap and fruit sampling.

The Jackson trap is a laminated cardboard trap that is baited every 2 weeks with a dental wick (1.9 by 3.8 cm) containing 2 ml of the synthetic attractant Trimedlure®. The inside of the trap is coated with a sticky substance that Medflies stick to when they enter the trap. The traps will be placed in the middle third of the host tree canopy and checked about every 7 days. Approximately 30,000 Jackson traps will be used in the monitoring effort. It will be the responsibility of the project cooperator to ensure proper and effective operation of the traps.

Fruit sampling will be a year-round activity, with major emphasis on sampling of the principal Medfly host fruit in the release areas. Periodically, sampling of primary and secondary hosts outside of the release areas will be done when the fruit is in season. Following sampling, dissection of the fruit in the laboratory will take place to determine the presence of Medfly larvae. Some of the fruit will be held in cages in the laboratory and observed for emerging Medflies and parasitoids.

Data from the traps and fruit samples will be used to determine the presence of feral Medflies in areas thought to be uninfested, to determine the seasonal distribution and abundance of feral Medfly populations in various Guatemala ecosystems, and to confirm the ratio of released sterile medflies to feral Medflies.

Monitoring continues indefinitely following cessation of control measures so that the measures' effectiveness may be confirmed and any new introductions detected. High-density monitoring is based on the length of time required for the Medfly to complete its life cycle, with a margin for safety. The length of time required for a complete life cycle is dependant primarily upon temperature, but is also influenced by the host fruit involved. The high variability in development time complicates the monitoring program design. Monitoring guidelines have been established that involve temperature data recorded from above-ground and below-ground environments; threshold limits are established for a range of temperatures in which development is expected to take place. Determination of Medfly persistence after cessation of eradication effort would probably require continuous monitoring for at least 1 year following the last application or control.

VI. Affected Environment and Environmental Consequences

A. Guatemala Environment

1. Human Population

Guatemala has the most diverse indigenous population of any Central American country, with three predominant ethnic groups: Spanish, Indian, and Ladino (Indians intermixed with Spanish who have adopted non-Indian culture). Pure Indians comprise nearly 55% of the population. The majority of the Indian population live in the western highlands and in the Departments of Alta and Baja Verapaz.

Over 30 native languages are spoken in Guatemala. Most are different enough to be not mutually understandable. In some parts of the country, such as Alta and Baja Verapaz, where Keckchi is the dominant language, estimates of monolingualism (e.g., no Spanish fluency) are as high as 90%. Nationwide, monolingual non-Spanish speakers account for an estimated 50% of the population (Rafael Landivar University, 1984). The distribution of monolingualism is skewed among specific groups, especially women. Of the population age 15 and older, only 40% are literate in Spanish (Rafael Landivar University, 1984).

Approximately 33% of Guatemala's population live in urban areas concentrated around the capital city. The urban population was estimated at 2.9 million in 1988. Of the 21 departments in the country, only the Departments of Guatemala (where the capital is located) and Sacatepequez (the department adjacent to the capital) are considered urban. The rate of growth in urban population appears to be decreasing. Between 1960 and 1970, 1970 and 1980, and 1980 and 1985, growth rates in urban areas were 45.8%, 48.1%, and 23.0%, respectively. The largest cities in each region are the department capitals, such as Quetzaltenango, Coban, Huehuetenango, Escuintla, and Puerto Barrios.

Guatemala's population growth rate has increased as much as 3.5% during some years of the past three decades. In 1988 the estimated population was 8.7 million and the annual rate of increase was 3.2%. At this rate the population would reach 12.2 million by the year 2000, and double in the next 22 years.

The population of Guatemala is unevenly distributed. Nearly two-thirds of the people live in the central highlands. Although the overall population density appears low at 79 persons/km^2, when density is calculated on the basis of cultivated land, the figure increases to 469 km^2. Even so, living accommodations for persons working these lands are concentrated in small areas resembling small towns near the landholders' dwellings. The government has developed policies to induce settlement in frontier areas, such as the Peten and the area around Huehuetenango, Coban, and along the border with Mexico (Leonard, 1987).

The quality of life in Guatemala, although improving, is still below acceptable levels for many segments of the population. Life expectancy is 61 years, and infant mortality is estimated at 65 deaths per 1,000. Malnutrition, especially in children, is widespread. Eighty percent of children have a weight-to-age relationship that indicates inadequate growth, and 79% of the rural population is undernourished (Delgado, 1987). Lack of potable water contributes to a variety of gastrointestinal problems and is linked to the high infant mortality. Potable water is available to only 45% of the total population and 18% the rural population (Leonard, 1987).

Income inequality is prevalent; the poorest 20% of the population correspond to only 5% of the national income, while the richest 20% correspond to 54%, according to a 1980 study (Leonard, 1987). The Indian population generally is worse off than the Spanish or Ladino population, as reflected by lower income and quality of life indicators.

Civil strife has been a common part of life in many areas of Guatemala for several decades, especially since the military coup in 1954. Although the country is now under civilian rule with a democratically elected president, aftereffects of the civil strife are still apparent, and in some parts of the country, insurgency and counter-insurgency activities continue. Estimates of the incidence of violence indicate that as many as 150,000 people may have died since 1970, and since 1980, 150,000 have migrated to Mexico for political reasons (Bazzy, 1986). The turmoil has made many Guatemalans, especially the rural and Indian populations, apprehensive of outsiders, including those in their own government. The effect of this outlook is acknowledged and the Guatemala MOSCAMED Program now incorporates integral public information activities.

2. Geography

a. Landforms

Guatemala is the northernmost and most populous of the Central American Republics. Its neighbors are Mexico, Belize, Honduras, and El Salvador. It has a Pacific coastline 320 km (200 mi) long and an irregular Caribbean coastline that spans only 80 km (50 mi).

There are 10 major physiographic regions in Guatemala: the Pacific Coastal Plain, the Recent Volcanic Slope, the Volcanic Range, the Crystalline Highlands, the Sedimentary Highlands, the Motagua and Izabal Depression, the Interior Lowlands of Peten, the Lacandon Folded Belt, the Yucatan Plateau, and the Caribbean Coastal Plain. The sparsely populated Department of Peten makes up the northern third of the country. The Sierra Madre and Cuchumatanes mountain ranges divide the Pacific Coastal Plain, the highlands, and the Caribbean Coastal Plain. The heavily populated central highland region, where Guatemala City is located, constitutes about one-fifth of the country's land surface. The Pacific

Coastal Plain is a fairly narrow belt between mountains and ocean, and the Caribbean Coastal Plain has fertile river valleys.

Guatemala is positioned atop three tectonic plates which contribute to a geological instability characterized by earthquakes. There are over 30 volcanoes in Guatemala's highland interior; several of the volcanoes are still active.

Guatemala's ground cover ranges from sparse backyard plantings of ornamental or fruit trees, to major agricultural areas, to tropical rain forests. The accessibility of Guatemala's terrain influences the operational characteristics of Medfly control. In flat lowland areas, aerial applications of malathion bait or sterile insects can be applied by fixed-wing aircraft. Areas of the central highlands and areas near Coban are too rugged and broken for fixed-wing aircraft; helicopters or ground crews make applications in these areas.

b. Soils

Guatemala's soils vary extensively in character. The Pacific lowland soils are primarily volcanic in origin and agriculturally productive. The Pacific coast slopes are dominated by alluvial, humic gley and grumosol soils.

Androgenic soils occur in the mountainous areas of the central highlands. The northern portion of the country, the Peten and Transversal, is dominated by terra rosa (red clay) and rendzina (black or dark brown clay) soils. Highland soils range from rich volcanic soils to thin, rocky mountain soils and are not suited for intensive cultivation. Poor drainage also limits agricultural use of many soils throughout the Peten and also the Atlantic lowlands.

Acid fibrous peat, interspersed with low ridges of beach sand, is found in the area northeast of Puerto Barrios along the Gulf of Honduras. Soils originally covered by lowland forests are productive but rapidly deteriorate when farmed intensively.

Hillside and highland zones comprise 82% of the total land area of Guatemala; these zones contain 35% good deep soils, 14% poor deep soils, and 51% thin soils (Leonard, 1987). The FAO-UNESCO classification system lists four major soil groups: Cambisoles (20%), Luvisoles (22%), Rendiznas (14%), Acrisoles (10.5%), and Nitosoles (9.3%) (Rafael Landivar University, 1984).

c. Climate

The general climatic conditions vary from mild to very hot and from wet to very wet tropical zones. Guatemala has two seasons—wet (May to October) and dry (November to April).

The annual mean temperature in the tropical lowlands of both coasts is about 25°C; this contrasts the range of 10-20°C in the highlands. In lowland areas during summer months, a maximum daily temperature of 32°C is common. A maximum daily temperature of 26°C is common during winter in the lowlands.

Intertropical convergence is the primary phenomenon affecting rainfall, although tropical storms and cold fronts are also influential factors. Rainfall is heaviest in central Guatemala along the slopes exposed to the Caribbean winds and in the south along the slopes exposed to the Pacific winds. The Atlantic lowlands receive rainfall throughout the year and support moist tropical forests. Average annual days of rainfall there vary from 150 to 210 (rainfall is heaviest from June to November), and annual rainfall is 2000 to 4000 mm. The upper Motagua valley, located on the Atlantic side of Guatemala, is the driest part of the country with an annual rainfall of 500 mm falling over a period of about 60 days. The Pacific lowlands have a short, intense rainy season and annually receive about 2000 mm over a period of 120 to 150 days. The highland mountains and plateaus are temperate and relatively dry, although they may be cold and wet at higher elevations. Intense storm activity in the lowlands during the rainy season limits Medfly control activities.

Winds rarely exceed 80 km/hr in any part of the country (Rafael Landivar University, 1984). Wind and rain influence the ability to conduct aerial applications for control of Medfly; aerial spraying and releases will take place in the morning when winds are generally calmer. Similarly, operations will be suspended during periods of rainfall.

3. Wildlife

Guatemala is a transitional zone between the northern Nearctic and the southern Neotropical fauna. It has a broad range of ecosystems, ranging from temperate (dominated by conifers and broadleaved trees) to tropical and subtropical habitats. This broad range of ecosystems results in a diverse variety of habitat for plant and animal life.

Central America, especially Guatemala, has been the center of extensive migrations of northern and southern animal species. Major interchanges of fauna have occurred throughout recent geological time. Guatemala, with its diverse habitats, has also been a center of evolution of new flora and fauna. Approximately 1,453 vertebrate species are reported there, excluding marine fish. Guatemala currently has a rich fauna of more than 600 bird species, more than 200 species of reptiles and amphibians, 250 species of mammals, and 28 species classified as game species. Unfortunately, many species in Guatemala are endangered or threatened with extinction, especially through loss or alteration of their habitats. Refer to table VI-10 for a listing of animal and plant species that are endangered, threatened, or of concern in Guatemala.

Guatemala has a diverse mammalian fauna representing the southern limit for some species that are typically North American, and the northern limit for others that are typically South American. Some smaller species, such as Anthony's spiny pocket mouse (*Liomys anthonyi*), the big deer mouse (*Peromyscus grandis*), and the Guatemala vole (*Microtus guatemalensis*), are endemic to Guatemala and occur nowhere else in the world. There are over 90 bat species, 6 squirrel species, and other animal species including opossums, shrews, anteaters, foxes, raccoons, weasels, skunks, mountain lions, peccaries, manatees, gophers, mice, and rats. Populations of mountain lions, peccaries, and manatees are rapidly dwindling.

Colorful and exotic bird life abounds in Guatemala. Of particular interest is the resplendent quetzal, the national bird of Guatemala, which is found principally in the montane forests of Quetzaltenango, Huehuetenango, El Quiche, Alta Verapaz, and Baja Verapaz. Lake Atitlan was the historic habitat of the Atitlan grebe. The total world Atitlan grebe population was entirely in Guatemala, and had been estimated recently at 90 to 100 individuals, but the species may be extinct now. Other birds of particular interest are the horned guan which inhabits the high forests of northwestern and central Guatemala and the brown pelican which is found on both the Atlantic and Pacific Coasts but which has disappeared from Lake Atitlan. These birds, particularly the quetzal and the Atitlan grebe, are considered valuable national resources.

Reptilian and amphibian life is also plentiful; 107 species of reptiles and amphibians, including frogs, turtles, crocodiles, lizards, and snakes, have been found in the Peten alone. Among endangered reptiles are the Morelet's crocodile (*Crocodylus moreletii*), which is protected by the 1970 Hunting Law, and several species of turtles.

The freshwater fauna includes 220 species. Species of *Tilapia*, carp, guapote, and freshwater shrimp are cultivated.

An estimated 8,000 species of vascular plants are found in Guatemala. Approximately 1,171 are endemic, including nearly 70% of Guatemala's high mountain vascular flora. Over 550 species of orchids are found in Guatemala, and may be found in trees of montane forests bordering coffee plantations or in trees within the plantations. Orchid diversity is greatest in the Coban area, on the volcanic slopes between Guatemala City and Mexico, in the Sierra de las Minas, and in the mountains bordering the Polochic River. Only an estimated 200 plants of the national flower, *Lycaste skinneri* (cited in CICP, 1988) designated in imminent danger of extinction by the International Union for Conservation of Nature and Natural Resources) are found in the Coban area. Another orchid, *Cattleya skinneri*, is found in coffee plantations and forests on volcanic slopes. Other extremely rare orchid species (*Eriopsis biloba, Lycaste dowiana*, and miniature species with very specific habitat requirements) previously known only in Costa Rica, have been discovered in forests bordering coffee plantations in the Polochic River area (Timscher, 1988). The orchid genus *Phragmipedium* is unique to the New World and all members of this genus are listed as endangered. In Guatemala this genus is represented by *P. caudatum* (=*warscewiczianum*) which has very large and showy flowers.

4. Land Use

Estimates of Guatemala's forest cover in 1980 ranged from 27 to 41% (Leonard, 1987). Approximately 40% of this cover lies in the country's temperate zone and consists mainly of conifers (16 species) and broadleaved trees (450 species). The remainder of the country is, or was, covered with tropical or subtropical forests. Much of the remaining forest land is secondary growth common in the transitional zones between the lowlands and highlands. Between 1970 and 1980, Guatemala's woodland and forest land declined an estimated 11% (Leonard, 1987). Forests have been cleared, in part, to expand agriculture and pasture land. While the conversion continues, much of the new cultivated land is not suitable for intensive agriculture. Other lands, such as steep hillsides, quickly erode when the forests are cleared.

Agricultural production contributes over 25% of the gross domestic product and provides jobs for 53% of the Guatemalan labor force. In Guatemala, as in other Central American countries, agricultural production and holdings are skewed: a large number of small farms produce commodities for domestic consumption while relatively few large farms produce commodities for export. Large export enterprises occupy 72% of the available land. Of the total agricultural landholdings in the country, 0.2% make up 36% of the land area (Leonard, 1987). Subsistence farms, which support most of Guatemala's rural population, comprise 28% of the landholdings of less than 1 ha (Rafael Landivar University, 1984). The rapid population increase in rural areas has forced farming on marginal lands and has added to the problem of deforestation.

5. Water Resources

Guatemala receives about 220,000 billion m^3 of annual rainfall, with 45% turning into superficial runoff. There are three principal watersheds: the Pacific watershed with 19% of the total runoff (surface area of 24,000 km^2), the Atlantic watershed with 34% of the total runoff (surface area of 34,100 km^2), and the Gulf of Mexico watershed with 47% of the average annual total runoff.

Guatemala has over 300 major lakes with a combined surface area of 1000 km^2. Lake Izabal in the Atlantic watershed (590 km^2) and Lake Atitlan (130 km^2) in the Pacific watershed are the largest. Surface water pH values in Guatemalan lakes range from neutral or 7.0 to slightly alkaline at 8.6, with most of the values between 7.5 and 8.0 (Brezonik and Fox, 1974). There is no evidence of acidic waters in any of the lakes, even though the highland lakes are in a volcanic area and three of them (Calderas, Encantada, and Tortugas) are within sight of an active volcano (Pacaya).

The Usumacinta River, with a basin of 51,538 km^2, is the largest river, dominating water flow into the Gulf of Mexico. The Motagua, which flows to the Atlantic, has the largest basin (14,453 km^2) in that watershed. All of the river systems in the Pacific slope are relatively small, although many are fast running, especially in the rainy season. Available groundwater is concentrated on the Pacific Coast, in the volcanic valleys of the highlands, and in the valleys of the largest rivers such as the Motagua and the Polochic. The primary rivers in or near Guatemala MOSCAMED Program areas are the Rio Motagua, Rio Polochic, Rio Naranjo, Rio Dulce, Rio Samala, Rio Nahualate, and Rio Suchiate. The program treatment areas are predominantly on the slopes above these rivers in commercial coffee plantations and fruit orchards. These treatment areas are generally from 500 to 2000 meters above sea level.

Water quality throughout much of Guatemala is poor. Extensive deforestation has led to heavy siltation of much of the available groundwater. Water quality has been affected adversely by siltation especially in the Crystalline Highlands, Sedimentary Highlands, and the recent Volcanic Slope. Contamination of drinking water has occurred due to bathing and washing in lakes, rivers, and streams. Furthermore, there are not enough sewage treatment plants. Several of these sustained damage during recent earthquakes. Lake Izabal has been impacted by sediment input as a result of deforestation and mining operations, and Lake Atitlan is under severe pressure from a variety of sources, including: sediment from agricultural development, pesticide and fertilizer usage, unregulated growth of the tourist industry, and wastes dumped into the lake.

B. Potential Environmental Consequences

The potential environmental consequences anticipated or feared as a result of the Guatemala MOSCAMED Program are related principally to the program application of chemical pesticide. The potential effects of program use of malathion on human health and nontarget organisms in Guatemala are therefore the primary considerations of this environmental analysis. In order to provide an accurate and meaningful analysis of the potential effects on humans and nontarget species, it is first necessary to consider in some detail: the expected environmental fate of the chemical, its potential effects on water quality and air quality, its demonstrated effects on humans and nontarget species, and the potential exposure of humans and nontarget species to the program chemical. The information is then correlated to determine relative risk for humans and nontarget species.

Health risks to humans because of the Guatemala MOSCAMED Program are evaluated by comparing dose estimates for workers and the public with appropriate hazard levels, as determined in tests on laboratory animals.

Risks to Guatemalan nontarget species because of the Guatemala MOSCAMED Program are assessed using representative Guatemalan amphibian, bird, fish, insect, and mammalian species. The effects to terrestrial and aquatic species from malathion exposure were determined by comparing estimated exposures to lethal levels established in laboratory animal studies. In addition, endangered and threatened species have been identified and separately assessed in appendix 8.

1. Environmental Fate

Malathion, an organophosphate, is a colorless-to-light amber liquid. Its preferred chemical name is O,O-dimethylphosphoro-dithioate diethylmercaptosuccinate. The physical and chemical properties of malathion are listed in table VI-1.

Varied values for the half-life of malathion in soil may be found in the literature (Gunther and Gunther, 1981; Curley and Donohue, 1986). The values range from 0.5 to 11 days. The rate of hydrolysis of malathion is directly related to soil type, organic content, and microbial populations present (Mulla et al., 1981). The more alkaline the soil pH (pH greater than 7), the higher the organic content, the greater the concentration of metabolically active microbial populations, and the more rapid malathion's degradation (Gibson and Burns, 1977). Malathion is known to be degraded by some common bacteria: *Anthrobacter* and *Rhizobium* and the fungal genus *Trichoderma* (Matsumura and Boush, 1966; Walker and Stojanovic, 1973). Any volatilization of malathion from the soil to the air is expected to be negligible due to malathion's low volatility coefficient. Leaching of malathion is not expected to occur because malathion has a strong tendency to bind with soil particles (Curley and Donohue, 1986). This is especially true in soils with a high organic content, such as agricultural cropland.

Malathion is not rapidly degraded by photolysis (Toia et al., 1980). Due to its low volatility, significant amounts of malathion would not be present in the atmosphere (table VI-1).

Malathion is degraded in aquatic environments by the same mechanisms as those found in soil environments. The half-life of malathion is reported to range from 36 hours to 26 days (Eichelberger and Lichtenberg, 1971; Wolfe et al., 1977). In aquatic environments the rate of hydrolysis is also dependent on the water's pH and organic content (Mulla et al., 1981). In aquatic systems, photolysis may play a major role in malathion degradation (Zepp and Cline, 1977). Malathion is removed from aquatic systems by adsorption to suspended particles, but is not removed by volatilization or precipitation as a solid (Wolfe et al., 1977). Refer to table VI-13 for data relative to the persistence of malathion over time.

The bioaccumulation potential for malathion is low (Chiou et al., 1977). This is indicated by malathion's low octanol-water partition coefficient and high solubility (table VI-1). Carp have not been shown to bioaccumulate malathion above ambient concentrations (Bender, 1969). The World Health Organization (WHO) has examined organophosphate insecticides and malathion and parathion in particular (Anonymous, 1989). WHO has determined that birds and mammals are much more efficient in detoxification of malathion than insects or fishes (Anonymous, 1989).

The degradation of malathion on plant surfaces is dependent on the type of plant and amount of insecticide applied (table VI-2). Malathion residues on plant surfaces will be discussed in section VI.B.2.b.

TABLE VI-1. PHYSICAL AND CHEMICAL PROPERTIES OF MALATHION

Purity	98.5% - 99.5% (analytical grade) 91.5% (technical grade)
Boiling point	156°C @ 0.7 torr[a]
Melting point	2.85°C
Refractive index	1.4598 (25°C)
Vapor pressure	1.25×10^{-4} mm Hg (20-25°C)
Octanol-water partition coefficient	781
Solubility	145 ppm (20-25°C)

[a]torr = 1/760 atmosphere.

Source: Dobroski and Lambert, 1984.

TABLE VI-2. RESIDUES OF MALATHION ON DIFFERENT PLANTS AT VARIOUS TIMES AFTER APPLICATION

Crop	Formulation[a]	Application rate (1 lb/A)	Post application time[b]	Residues (ppm)
	Note: The MOSCAMED Program uses an EC formulation at an application rate of 0.095.			
Bean (lima)	dust	0.8	1h	74.0
			1d	18.0
			2d	0.0
Cabbage	EC	0.63	4h	14.7
			1d	13.3
			2d	8.6
			7d	2.4
Carrot	dust	1.75	1h	0.5
	EC	1.75	1h	0.1
	WP	1.75	1h	1.0
Cucumber	dust	1.75	1h	2.9
			1d	0.3
	EC	1.75	1h	1.3
			1d	trace
	WP	1.75	1h	0.8
			1d	0.2
Lettuce	dust	0.4	4h	14.1
			1d	4.4
			2d	1.7
			3d	1.0
	EC	1.75	1h	26.1
			1d	28.9
			3d	16.9
			7d	13.2
	WP	1.75	1h	18.1
			1d	19.9
			3d	15.8
			7d	8.5
	aerosol	1g/1000 ft^3	1d	9.75
			3d	3.46
			6d	0.85
			9d	0.46
			12d	0.0
Onions (tops)	EC	1.0	1d	7.15
			3d	0.0
Tomato (fruit)	aerosol	1g/1000 ft^3	1h	0.36
			1d	0.20
			3d	0.0
			6d	0.0
			9d	0.0
			12d	0.0
Red raspberry	dust	1.75	1h	5.6
			1d	5.1
	EC	1.75	1h	4.0
			1d	0.6
	WP	1.75	1h	6.4
			1d	5.3

TABLE VI-2. (continued) **RESIDUES OF MALATHION ON DIFFERENT PLANTS AT VARIOUS TIMES AFTER APPLICATION**

Crop	Formulation[a]	Application rate (1 lb/A)	Post application time[b]	Residues (ppm)
Tangerine	EC	1.5g a.i./L	1d	7.2
		38L/tree	7d	5.1
		3 triweekly	14d	1.8
		applications	21d	1.5
Valencia orange	EC	1.5g a.i./L	1d	9.8[c]
		38L/tree	7d	4.3[c]
		3 triweekly	14d	2.0[c]
		applications	21d	1.5[c]
Pear	EC	0.93 lb/100 gal	0d	1.6
			7d	trace
			14d	trace
Alfafa	EC	1.0	1d	46.6
			5d	8.1
			10d	0.8
			15d	0.4
			30d	<0.2
Corn	EC	10ppm	1d	9.7
		(w/w)	6m	5.2
			12m	3.4
Green gram	EC	50ppm	0m	46.3
			2m	38.5
			4m	28.2
			6m	15.8
			8m	9.0
			10m	2.9

[a] EC—emulsified concentrate; WP—wettable powder.
[b] h—hour; d—day; m—month.
[c] Calculated from graph data.

Adapted from Mulla et al., 1981.

Malaoxon, an oxidative degradation product of malathion, is a more potent acetylcholinesterase (AChE) inhibitor than malathion. Malathion may be oxidized to malaoxon via enzymatic systems termed mixed-function oxidases (Rowlands, 1965; Matsumura, 1975; Munnecke and Hsieh, 1976). Mixed-function oxidases are found in animal, plant, and microorganisms. However, the oxidation of malathion to malaoxon is not the preferred degradation pathway in animal, plant, or microorganisms (Mulla et al., 1981). The preferred degradation pathway is hydrolysis (Pascal and Neville, 1976). This degradation yields nontoxic intermediates. Any malaoxon produced is unstable and quickly degraded to non-toxic intermediates (El-Rafai and Hopkins, 1966). Chemical oxidation (i.e., nonbiological) of malathion to malaoxon has been shown by several investigators (Cook, 1955; Mulla et al., 1981). However, the conditions necessary for this reaction are not found in natural environments. Chemical degradation of malathion in the natural environment is via hydrolysis, yielding nontoxic intermediates (Pascal and Neville, 1976). Malaoxon is not produced in appreciable amounts in the environment by chemical means or by microorganisms, and any malaoxon produced by animals or plants is unstable and quickly degraded. Consequently, malaoxon is not expected to have an adverse impact on workers, the general public, or the environment.

2. Human Health

a. Human Health Risk Assessment Overview

In order to assess the potential effects on human health of the Guatemala MOSCAMED Program's use of malathion, it is necessary to determine (1) the possible health effects attributable to malathion, (2) the expected exposure to humans as a consequence of program use of the chemical, and then (3) the probability of effect or risk to human health as a consequence of program use of the chemical. These are the three principal analytical elements necessary to characterize the potential adverse health effects of human exposures to existing or introduced hazards in the environment (National Research Council, 1983). They are known widely as: hazard analysis, exposure analysis, and risk analysis.

b. Human Health Hazard Analysis

Toxic effects to humans from malathion, an acetylcholinesterase (AChE) inhibitor, include: headache, nausea, vomiting, loss of appetite, blurred vision, weakness, and muscular twitching at high doses. No developmental effects have been observed in laboratory animal studies (EPA, 1988a).

Carcinogenic studies conducted by the National Cancer Institute have shown that malathion is noncarcinogenic (NCI, 1978). In 1985, Huff et al. reviewed the previous studies of long-term feeding experiments conducted by the National Cancer Institute and reaffirmed that malathion is not a carcinogen. The National Cancer Institute study, however, indicated that malaoxon, an oxidative degradation product of malathion, causes C-cell neoplasms in mouse thyroid cells. The subsequent review by Huff et al. confirmed that malaoxon is a carcinogen.

Review of available literature disclosed only one scientific article that stated that malathion alone is a carcinogen (Reuber, 1985). Despite a great deal of evidence to the contrary, a cautious approach to the hazard determination in this analysis has resulted in our estimation of the cancer potential of malathion as 0.00376 $(mg/kg/day)^{-1}$.

Current data indicate that neither malathion nor malaoxon are mutagens, but malathion may be a weak chromosomal breakage inducer (Houk and DeMarini, 1987).

A reference dose for malathion of 0.02 mg/kg/day is recommended by the World Health Organization and EPA (EPA, 1988c). Several studies have examined the potential health effects to humans from subchronic levels of malathion (Degraeve et al., 1984; Grether et al., 1987).

The effects of low levels of organophosphate insecticides, including malathion, in drinking water were considered. The residue levels of insecticide tested were the maximum levels allowed for fruit and vegetables. In the study, 8 ppm malathion in water was administered in water to male mice for five days a week for a period of 7 weeks (See table VI-6). No chromosomal damage was detected in bone marrow, spermatogonia, or primary spermatocytes. Litter sizes were normal when compared to the control animals. The authors concluded that the maximum allowable level of malathion and other organophosphate insecticide residues in fruits and vegetables are low enough to avoid any potential hazards for human consumption (Degraeve et al., 1984).

The aerial-spraying of malathion and birth defects or low birth weight in the San Francisco Bay area was examined (Grether et al., 1987). No biologically plausible association was found between low-level malathion exposure and birth defects or low birth weight.

Malathion has been shown to be synergistic when combined with other organophosphates (EPA, 1988a). This means that the toxicity of the chemical mixture is greater than the additive toxicities of the individual chemicals.

c. Human Health Exposure Analysis

The risk assessment includes analyses of a range of possible exposures to malathion applications, from those that are likely to occur, to those that are extremely unlikely to occur. Three cases are analyzed in the risk assessment. The first of these (typical) is represented by the dose likely to occur to workers or the public from a typical malathion application exposure. The second (extreme) is represented by a dose which could occur to workers and the public with extreme values for the malathion application exposure. The third case (accidental) is represented by an accidental or direct exposure to the spray mix or concentrate for both workers and the public. A clarification between dose and exposure is necessary. Dose is defined as the amount of a given chemical which actually enters the body; exposure is the amount of a given chemical in the environment potentially available to be taken into the body.

d. Human Health Risk Analysis

(1) Human health risk analysis methods

Potential risks to the exposed human population are considered for two groups. The first group (workers) includes aerial and ground applicators, observers, and other personnel directly involved in the application of malathion. The second group (the public) includes passersby or nearby residents.

The human health risks from the Guatemala MOSCAMED Program were evaluated by comparing estimated doses (calculated from typical, extreme, and accidental exposure scenarios) to workers and the public to the laboratory-determined toxicity levels. To quantify the risks of acute, chronic, and reproductive/developmental human health effects, estimated doses were compared to laboratory "no-observed-effect levels" (NOELs). NOEL values used in this EA are presented in table VI-3. The ratio between the NOEL and the estimated human dose level is termed the margin of safety (MOS). Mathematically, MOSs are equal to the NOEL divided by the dose (table VI-4). For malathion, an MOS of 10 is recognized as safe for humans by EPA (EPA, 1988a). The risk to human health increases as the ratio number becomes smaller. A MOS value of 1 would indicate a dose equal to the NOEL for malathion (tables VI-3 and VI-4). MOS values that are negative exceed the NOEL value and indicate higher than significant human health risks (table VI-4).

(2) Calculated risk to workers

For calculating the risk to workers, several criteria are employed. The first is that for all workers, the potential routes of exposure are dermal and inhalation. The second, for typical exposures, provides: that all workers are experienced, observers are exposed to drift 100 feet from the area of application, all safety precautions are not necessarily taken, the work day is 5 hours, and no degradation of malathion occurs. The third, for extreme exposure, provides: that workers receive fourfold the typical dose, safety precautions are not followed, observers are exposed to drift 25 feet from the area of application, the workday is 10 hours, and no degradation of malathion occurs. The fourth, for accidents, provides: that a worker(s) is accidentally covered with 0.5 liters of malathion concentrate, reenters the spray area immediately after spraying operations, or immediately consumes directly sprayed fruits or vegetables.

In the Guatemala MOSCAMED Program risk analysis, backpack spray applicators are considered at highest risk. However, others (Lavy et al., 1982) have shown that backpack sprayers are statistically at no more risk than are mixer/loaders. The systemic margins of safety (MOS) for backpack spray applicators are in the acceptable risk range for typical applications of malathion, but fall into the slight to moderate risk range for the

TABLE VI-3. GUATEMALA MOSCAMED PROGRAM TOXICITY REFERENCE LEVELS USED IN THIS ANALYSIS

Insecticide	Acute oral LD_{50} in rats (mg/kg)	Systemic NOEL (mg/kg/day)	Reproductive/ developmental[a] NOEL (mg/kg/day)
Malathion	370	0.23	25

[a]Inhalation study was the only reproductive/developmental study available.

Sources: EPA, 1988a; EPA, 1988c; NIOSH, 1987.

TABLE VI-4. GUATEMALA MOSCAMED PROGRAM MARGINS OF SAFETY (MOS) FOR MALATHION[a]

Exposure	Systemic		Reproductive	
	Typical	Extreme	Typical	Extreme
Public:[b]				
Dermal/inhalation	5,798	2,400	10,000	10,000
Dietary:				
Water	6,461	1,077	10,000	10,000
Fish	697	116	10,000	10,000
Venison	752	150	10,000	10,000
Peas	1,095	219	10,000	10,000
Raspberry	241	48	10,000	5,236
Workers:[c]				
Pilot	1,046	260	10,000	10,000
Mixer/loader	496	117	10,000	10,000
Observer	121	30	6,775	3,289
Evaluation team[d]	10,000	8,428	10,000	10,000
Backpack sprayer	62	8	6,775	847
Accidents:				
Spill of concentrate		–1,050		–10
Broken hose		–1,050		–10
Immediate field entry		8,456		10,000
Eating peas—direct spray		164		10,000
Eating raspberry— direct spray		36		3,894

Note: Margins of safety are based on a systemic NOEL of 0.23 and a reproductive NOEL of 25.0; margins of safety greater than 10,000 are listed as 10,000 for convenience (EPA, 1988a; NIOSH, 1987).

[a]Margins of safety greater than 10 are considered acceptable levels of risk.

[b]Dermal and inhalation exposures, typical at 500 feet and extreme at 100 feet. Dietary exposures, typical at 100 feet and extreme at 25 feet.

[c]Worker exposures: typical is based on average dose for a 5-hour day and extreme is based on 4x average dose for a 10-hour day.

[d]Evaluation team: typical reentry time is day 1 and extreme reentry time is day 0.

extreme application scenario (table VI-4). The remaining worker MOSs are all above the acceptable level for both systemic and reproductive risks (table VI-4). If all labeling instructions are followed, worker risk would exceed the acceptable level for malathion application in the program.

Workers may be at significant and unacceptable risk due to direct contact with spillage of concentrated malathion or diluted formulation. This assessment is based on both systemic and reproductive NOEL's (table VI-4). The accidental consumption of 500 grams of directly sprayed foodstuffs has some potential risk, but still remains above the acceptable level. However, immediate field reentry does not pose a risk for the worker in the Guatemala MOSCAMED Program. Risks due to accidents are reduced through adherence to operational procedures and good work safety practices. MOSs for systemic and reproductive risks are presented in table VI-4. Established United States federal and California State field reentry intervals for malathion are shown in table VI-5.

The Guatemala MOSCAMED Program is expected to have a negligible cancer risk to workers. A lifetime carcinogenic risk estimate of 1.0×10^{-8} is calculated from the MOS value (table VI-4). This estimate is based on the following worst case assumptions: MOS value of 8, equivalent to 0.20875 mg/kg/day; a worker receives this daily dose for the entire Guatemala MOSCAMED Program period; a malathion carcinogenic potential of 0.00376 $(mg/kg/day)^{-1}$; and an average life span of 70 years. A lifetime carcinogenic risk estimate, due to an accident, is calculated as 6.71×10^{-5} from MOS value (table VI-4). This estimate is based on the assumption that a worker is exposed to one worst case accidental spill event (MOS value of –1,050; equivalent to 4565 mg/kg/day) during the course of the Guatemala MOSCAMED Program, a malathion carcinogenic potential of 0.00376 $(mg/kg/day)^{-1}$, and an average life span of 70 years. Cancer risk estimate values larger than values in the range of 10^{-5} to 10^{-6} are considered to be significant (EPA, 1986b; ENVIRON, 1988).

(3) Calculated risk to the public

The potential public exposure to malathion is expected to occur via dermal, inhalation, and dietary intake routes. Dietary intake estimates are based on the consumption of 2 liters of water, and 500 grams of meat from sprayed animals, fruits or vegetables each per day, without considering malathion degradation. The risk assessment for the typical case involves dermal and inhalation exposure at 500 feet and exposure to foodstuffs at 100 feet from the application area. The extreme scenario uses exposures at 100 feet and 25 feet, respectively. The Guatemala MOSCAMED Program is not expected to put the public at unacceptable risk (table VI-4). Permissible malathion residual levels on food commodities for various countries is listed in table VI-6. Malathion drift due to aerial application of the pesticide is not expected to have an adverse affect on the general public (Marx, 1981). The protein in the bait spray will cause the particles to congeal as they fall. Therefore, the congealed particles will be larger, minimizing drift and inhalation potential (Marx, 1981).

TABLE VI-5. FIELD REENTRY INTERVALS FOR CROPS TREATED WITH MALATHION[a]

	Interval (days)	
Crop	U.S. Federal	California
Apples	2	—
Citrus	2	1
Grapes	2	1
Nectarines	—	1
Peaches	2	1
Tobacco	2	—

[a]Used at label rates.

Adapted from Mulla et al., 1981.

TABLE VI-6. ESTABLISHED TOLERANCES FOR MALATHION ON CITRUS AND OTHER FOOD COMMODITIES IN DIFFERENT COUNTRIES

Country	Tolerance (ppm)
Canada	4.0 and 8.0
EEC[a]	0.5[b]
Holland	3.0
India	8.0
USA	8.0
USSR	8.0
West Germany	0.5

[a]European Economic Community.

[b]Proposed.

Adapted from Mulla et al., 1981.

The Guatemala MOSCAMED Program is expected to have a negligible cancer risk to the public. A lifetime carcinogenic risk estimate of 1.6×10^{-9} is calculated from the MOS values (table VI-4). This estimate is based on the following worst case assumptions: an MOS value of 48, equivalent to 0.0048 mg/kg/day of malathion; an individual consumes contaminated raspberries after each application of malathion for the duration of the Guatemala MOSCAMED Program; a carcinogenic potential of 0.00376 $(mg/kg/d)^{-1}$; and an average life span of 70 years. Cancer risk estimate values larger than 10^{-5} to 10^{-6} are considered to be significant (EPA, 1986a; ENVIRON, 1988).

The public is not expected to be at risk from the use of olote bait stations. The olotes use a cardboard roof, the corncobs are void of kernels and could not be mistaken as food, and the traps are placed in trees out of reach of the general public.

3. Socio-Economic Consequences

Malathion is a nonsystemic organophosphate insecticide of low mammalian toxicity that is used worldwide for veterinary, public health, and household uses (Khan and Dev, 1982). Public health use of malathion has included treatment of scabies and head lice in humans (Shacter, 1981).

Potential socioeconomic consequences of the Guatemala MOSCAMED Program have been analyzed separately in the "Economic Analysis of the Medfly Program in Guatemala," prepared by USDA, APHIS, Policy and Program Development (USDA, 1989). Refer to that document, incorporated by reference in this environmental analysis.

4. Nontarget Consequences

The potential impacts on terrestrial and aquatic species from using malathion in the Guatemala MOSCAMED Program are examined here. Risks to terrestrial and aquatic species from the Guatemala MOSCAMED Program are directly related to the inherent toxicity of malathion to different organisms and to the amount of malathion (dose) those organisms may take in as a result of malathion application.

For terrestrial species that are not considered endangered, the U.S. Environmental Protection Agency (EPA) considers there to be a significant and unacceptable risk if the dose exceeds the LD_{50} and a moderate risk if the dose is less than the LD_{50} but exceeds ⅕ the LD_{50}. For endangered terrestrial species, ⅒ the LD_{50} is the appropriate toxicity reference value. Doses below these levels are assumed to present a low or negligible risk (EPA, 1986b).

Toxicological studies that use all the representative terrestrial wildlife species are lacking for malathion. It may be necessary to use a closely related species for which toxicity data is available. In some cases, even this situation does not exist. Therefore, it is necessary to use an indicator species to determine potential toxicity effects (EPA, 1986). These indicators are selected according to the following criteria: (1) avian indicators may be used for avian species, (2) mammalian indicators may be used for mammalian species based on body weight and diet; and (3), toxicity data for indicator avian species has good correlation with the LD_{50}'s for amphibian and reptilian species (Hudson et al., 1984).

The risks of adverse effects, from exposure to malathion due to off-site drift (table VI-7) and from direct spraying of ponds (table VI-8), were estimated for representative aquatic species. Acute toxicity reference values, LC_{50} or EC_{50}, used in the analysis were selected for the representative species using laboratory and field studies. To estimate the risk of adverse effects, the selected toxicity reference values were compared to the estimated environmental concentrations (EEC) of malathion. The analysis examined the levels of malathion in ponds that may receive direct malathion spray and ponds that may receive drift from 25 feet. The ratio of the EEC to the LC_{50} or EC_{50} is termed the quotient-value (Q-value). The Q-value is numerically equal to the ratio EEC/(LC_{50} or EC_{50}) and is comparable to the MOS value (tables VI-4, VI-7, and VI-8). The Q-values estimate the risks of adverse effects to fish or invertebrates as follows: Q-values less than 0.1, no risk; 0.1 to 0.5, moderate risk; and greater than 0.5, significant risk (EPA, 1986b).

a. Wildlife

The Guatemalan terrestrial wildlife species analyzed in this document are not at adverse risk from malathion applications in the Guatemala MOSCAMED Program. Extrapolation of risk analysis data suggested concern for only one of the species, the black howler monkey. The black howler monkey's typical dose estimate is near the human acceptable daily intake (ADI) dose (table VI-9) and extreme dose scenario (table VI-9) exceeds the human daily exposure limit (Coelho et al., 1976). However, Guatemala's black howler monkeys are arboreal, inhabiting montane and rain forests (Coelho et al., 1976). These areas do not coincide with program treatment areas and therefore the black howler monkeys would not come into contact with program activities.

No Guatemalan amphibian is listed by either the Convention on International Trade in Endangered Species (CITES) or the Endangered Species Act (ESA). Guatemalan frogs can be divided into three groups: pond breeders, stream breeders, and tree frogs (leptodactyles). Pond breeders are found in the costal lowlands and generally breed at the beginning of the rainy season. Stream breeders reproduce primarily during the rainy season and are found more in the coffee-producing areas. Tree frogs, like salamanders, exhibit direct development bypassing the aquatic, larval stage. This group has more species but fewer overall numbers than either of the groups that breed in water (Campbell, 1990). Frogs are resistant to cholinesterase inhibitors. It is suspected that they might accumulate pesticides including malathion. Tadpoles have the ability to concentrate some pesticides up to 60 times the ambient concentration (Hall and Kolbe, 1980).

All 33 species of Guatemalan salamanders lay their eggs in moist leaf litter out of flood plain areas. This independence from an aqueous habitat is

TABLE VI-7. GUATEMALA MOSCAMED PROGRAM ACUTE RISK TO AQUATIC SPECIES IN PONDS RECEIVING DRIFT FROM MALATHION

Representative species	LC_{50} or EC_{50} (mg/L)	Q-value (EEC/LC_{50})	Risk level
	EEC[a] = 0.000625 mg/L		
Fish:			
Black bullhead	11.700	0.0001	no acute
Bluegill	0.030	0.0210	no acute
Channel catfish	8.970	0.0001	no acute
Fathead minnow	8.650	0.0001	no acute
Green sunfish	0.146	0.0040	no acute
Largemouth bass	0.285	0.0020	no acute
Yellow perch	0.263	0.0020	no acute
Invertebrates:			
Aquatic sowbug	3.000	0.0020	no acute
Daphnia 1st instar	0.001	0.6300	significant
Scud	0.00076	0.8200	significant
Grass shrimp	0.032	0.0200	no acute
Stonefly	0.0011	0.5700	significant
Amphibians:			
Fowler's toad	0.420	0.001	no acute
Western chorus frog	0.420	0.0003	no acute

Note: Refer to text for discussion of methods used in derivation of data.
[a]EEC = Estimated environmental concentration.

TABLE VI-8. GUATEMALA MOSCAMED PROGRAM ACUTE RISK TO AQUATIC SPECIES IN PONDS THAT ARE SPRAYED WITH MALATHION

Representative species	LC_{50} or EC_{50} (mg/L)	Q-value (EEC/LC_{50})	Risk level
	EEC[a] = 0.01754 mg/L		
Fish:			
Black bullhead	11.700	0.002	no acute
Bluegill	0.030	0.590	significant
Channel catfish	8.970	0.002	no acute
Fathead minnow	8.650	0.002	no acute
Green sunfish	0.146	0.120	moderate
Largemouth bass	0.285	0.060	no acute
Yellow perch	0.263	0.070	no acute
Invertebrates:			
Aquatic sowbug	3.000	0.006	no acute
Daphnia 1st instar	0.001	17.500	significant
Scud	0.00076	23.100	significant
Grass shrimp	0.032	0.550	significant
Stonefly	0.0011	16.000	significant
Amphibians:			
Fowler's toad	0.420	0.040	no acute
Western chorus frog .	0.420	0.090	no acute

Note: Refer to text for discussion of methods used in derivation of data.
[a]EEC = Estimated environmental concentration.

TABLE VI-9. GUATEMALA MOSCAMED PROGRAM RISK TO WILDLIFE SPECIES FROM MALATHION

Species	Typical dose estimate (mg/kg/day)	Extreme dose estimate (mg/kg/day)	1/5 LD_{50} (mg/kg)	LD_{50} (mg/kg)	Indicator species
Mammals:					
Black Howler Monkey (*Alouatta pigra*)	0.016[a]	0.078[b]	0.004[c]	0.02[c]	Human
Jaguarundi (*Felis yagouaroundi*)	0.090	0.470	37.00[d]	370.00	Rat
White-Tailed Deer (*Odocoileus virginianus*)	0.009	0.211	10.6	53.00	Cow
West Indian Manatee (*Trichechus manatus*)	0.004	0.268	5.3[d]	53.00	Cow
Birds:					
Common Bobwhite (*Colinus virginianus*)	0.235	1.267	80.00	400.00	Bobwhite
American Peregrine Falcon (*Falco peregrinus anatum*)	0.578	3.042	40.00[d]	400.00	Bobwhite
White-Fronted Parrot (*Amazona albifrons*)	0.235	1.267	80.00	400.00	Bobwhite
Reptiles:					
Alligator (*Alligator* sp.)	0.034	0.938	80.00	400.00	Bobwhite
Amphibians:					
Toad (*Bufo* sp.)	0.456	2.425	80.00	400.00	Bobwhite
Insects:					
Honey Bee (*Apis mellifera*)	0.03	3.36	1.182	5.908	Honey Bee
Domestic Animals:					
Cow	0.004	0.268	10.6	53.00	Cow
Chicken	0.050	0.288	30.00	150.00	Chicken
Dog	0.020	0.100	74.00	370.00	Rat

[a] Assume—typical public risk for dermal exposure/inhalation, water consumption 2 L, food consumption of 1005 g/day cayol leaves (a low-caloric source), and the food was as contaminated as red raspberries.
[b] Assume—extreme public risk using above parameters.
[c] Maximum human daily exposure.
[d] 1/10 LD_{50}

further shown in that all of these salamanders develop directly from the egg to an appearance like the adults, not undergoing a larval (tadpole) development. Over one half of all Guatemalan salamander species can be found associated with bromeliads. Terrestrial insects serve as the food source for all of the salamanders (Campbell, 1990).

It is expected that amphibians will not be directly affected by malathion bait applications, although their food chain may be temporarily affected. Refer to section B, Nontarget Consequences, for a detailed consideration of potential impacts to endangered and threatened species.

In general, aquatic species appear to be more sensitive than terrestrial species to malathion. The risk assessment for fish in ponds that receive drift from malathion application shows no acute risk to any fish nor to amphibians examined (table VI-7). However, direct spray of malathion to small ponds may exhibit significant and moderate risk to bluegill and green sunfish, respectively (table VI-8). The Guatemala MOSCAMED Program is not expected to impact other aquatic vertebrate species such as the manatee or alligator (table VI-9).

b. Endangered, Threatened, or Sensitive Species

Guatemala is rich in animal and plant resources, but as in many other areas of the world, some species are declining due to loss of habitat, agricultural practices, and human encroachment. The wild areas of Guatemala are continuously disappearing at an extraordinary pace due to deforestation, urban and industrial expansion, use of soil, contamination of natural resources, and changes in the natural hydrologic cycle. A late-awakening awareness of the roles of natural areas and animal and plant resources, and a weak legal base for protection of those resources, have done little to slow the rate of loss.

APHIS has used information from a variety of sources to develop a consolidated listing of species which are endangered, threatened, or of concern, within Guatemala. Neither APHIS nor Consortium for International Crop Protection (CICP) contacts were able to obtain an official listing of endangered or threatened species recognized by the Government of Guatemala. Table VI-10 is a consolidated listing of Guatemalan species which have been: (1) federally listed (50 CFR 17.11 & 17.12) by the United States as endangered or threatened under the Endangered Species Act, (2) identified to APHIS or CICP by the Government of Guatemala as species of concern, or (3) identified by authorities or researchers who provided comments to APHIS during the scoping process.

Refer to appendix 8 for individual assessments of species which are endangered, threatened, or of concern for Guatemala. In general, no adverse effects are foreseen as a consequence of the program for the assessed species. This is a result of the combination of positive steps taken by the Guatemala MOSCAMED Program to ensure the species' protection and the ecological relationships that uniformly insulate most species from program

TABLE VI-10. Guatemalan Endangered and Threatened Species

Species	Common name	Status[a]
Mammals:		
Alouatta palliata	Mantled howler monkey	E
Alouatta pigra	Black howler monkey	T
Ateles geoffroyi	Spider monkey	G
Felis concolor	Puma	G
Felis pardalis	Ocelot	E
Felis wiedii	Margay	E
Felis yagouaroundi	Jaguarundi	E
Leptonycteris nivalis	Mexican long-nosed bat	E
Leptonycteris sanborni	Sanborn's long-nosed bat	E
Lutra longicaudis	Long-tailed river otter	G
Mazama americana	Brocket deer	G
Myrmecophaga tridactyla	Giant anteater	G
Odocoileus virginianus	White-tailed deer	G
Panthera onca	Jaguar	E
Tamandua mexicana	Tamandua	G
Tapirus bairdii	Central American tapir	E
Trichechus manatus	West Indian manatee	E
Birds:		
Amazona albifrons	White-fronted parrot	G
Ara macao	Scarlet macaw	G
Burhinus bistriatus	Thick knees	G
Campephilus [melanoleucos] guatemalensis	Pale-billed woodpecker	G
Campephilus imperiales	Imperial woodpecker	G
Colinus virginianus	Common bobwhite	G
Dendroica chrysoparia	Golden-cheeked wood warbler	E
Electron carinatum	Keel-billed motmot	G
Falco deiroleucus	Orange-breasted falcon	G
Falco femoralis septentrionalis	Northern aplomado falcon	E
Falco peregrinus anatum	American peregrine falcon	E
Falco peregrinus tundrius	Arctic peregrine falcon	T
Grus americana	Whooping crane	E
Harpia harpyja	Harpy eagle	E
Harpyhaliaetus gregarius	Social eagle	G
Harpyhaliaetus solitarius	Solitary eagle	G
Meleagris ocellata	Ocellated turkey	G
Morphnus guianensis	Crested eagle	G
Mycteria americana	Wood stork	E
Numenius borealis	Eskimo curlew	E
Oreophasis derbianus	Horned guan	E
Pelecanus occidentalis	Brown pelican	E
Penelopina nigra	Black chachalaca (highland guan)	G
Pharomachrus mocinno	Resplendant quetzal	E
Podilymbus giga	Atitlan grebe	E

TABLE VI-10. Guatemalan Endangered andThreatened Species–cont.

Species	Common name	Status[a]
Birds (cont.)		
Sterna antillarum	Least tern	E
Sterna dougallii dougallii	Roseate tern	T
Tangara cabanisi	Azure-rumped tanager	G
Xenotriccus calizonus	Belted flycatcher	G
Reptiles:		
Alligator spp.	Alligator	G
Boa constrictor	Boa constrictor	G
Caiman crocodilus fuscus	Spectacled caiman	G
Caretta caretta	Loggerhead sea turtle	T
Chelonia mydas	Green sea turtle	T
Crocodylus acutus	American crocodile	E
Crocodylus moreletii	Morelet's crocodile	E
Dermatemys mawii	Central American river turtle	E
Dermochelys coriacea	Leatherback sea turtle	E
Eretmochelys imbricata	Hawksbill sea turtle	E
Heloderma horridum	Mexican beaded lizard	G
Iguana iguana	Green iguana	G
Lepidochelys kempii	Kemp's ridley sea turtle	E
Lepidochelys olivacea	Olive ridley sea turtle	T
Amphibian:		
Bufo spp.	Toad	G
Insect:		
Neoneura aaroni	Coral-fronted threadtail	G
Plants:		
Abies guatemalensis	Guatemalan fir	T
Cattleya skinneri	Flower of San Sebastian	G
Eriopsis biloba	Orchid sp.	G
Lycaste dowiana	Orchid sp.	G
Lycaste skinneri	White nun orchid	G
Magnolia guatemalensis	Guatemalan magnolia	G
Phragmipedium caudatum	Orchid sp.	G

[a] E = U.S. Federally listed Endangered Species
T = U.S. Federally listed Threatened Species
G = Guatemalan Species of Concern

activities. Many of the endangered or threatened species inhabit remote regions of the country that generally are not projected for program treatments. Therefore, those species would not be expected to come into contact with activities of the Guatemala MOSCAMED Program. Other endangered and threatened species inhabit areas which would not be proposed for treatment because they do not contain Medfly hosts or have been precluded from chemical treatment in order to provide environmental safeguards.

Guatemala has a variety of natural areas designated by the government as national parks or protected areas. The national parks may be biological reserves or public recreational sites with no wildlife or wilderness. Biological reserves (biotopos), which have been set aside for protection of endangered species, are managed by the Center for Conservation Studies; no Guatemala MOSCAMED Program treatments will take place in these areas. Refer to table VI-11 for a listing of sensitive areas which will not receive treatment. The Instituto Nacional Forestal (National Forest Institute—INAFOR) manages most of the government-owned parks. A variety of other organizations, mostly public sector and nonprofit, administer other natural areas. In addition, there are a number of privately owned reserves in Guatemala.

The Guatemala MOSCAMED Program maintains Medfly traps in protected and ecologically sensitive areas such as Lake Atitlan National Park, Rio Samala watershed (protected by the Instituto Nacional Forestal), and bordering volcanic forests proposed for protection near San Marcos. Malathion bait spray is not used in such areas. Helicopters are used to apply malathion bait spray selectively in unprotected, broken terrain and where coffee plantations and forests form a patchwork pattern. Where more exact targeting is required, ground spraying is used.

c. Domestic Species

Risk analyses for representative domestic species (cattle, chickens, and dogs) indicate no adverse risk as a consequence of malathion applications (table VI-9).

d. Invertebrate Species and Microorganisms

The Guatemala MOSCAMED Program may have adverse affects on aquatic invertebrate species. In ponds receiving drift from malathion application, daphnia, scud, and stonefly are at significant risk. However, the aquatic sowbug and grass shrimp are at no acute risk (table VI-7). In ponds that receive direct spray, daphnia, scud, grass shrimp, and stonefly are at significant risk while the aquatic sowbug is at no acute risk (table VI-8). See section VI.B.4.f, for a discussion of the potential effects of the Guatemala MOSCAMED Program on aquatic invertebrate species.

Malathion bait spray is known to have detrimental effects on some terrestrial invertebrates as well. Predaceous insects such as green lacewings

TABLE VI-11. GUATEMALA MOSCAMED PROGRAM SENSITIVE AREAS NOT TREATED

University of San Carlos Quetzal Preserve
Atitlan National Park (including Lago de Atitlan)
Volcan Atitlan Preserve
El Triunfo Preserve
El Hawaii
Laguna del Pino (Lago de Ayarza)
Las Victorias
Las Naciones Unidas National Park
San Jose la Colonia
El Rosario
Rio Dulce
Lago de Peten Itza
Laguna de Lachua
Grutas de Lankin
Riscos de Momostenango
Cerro del Baul
El Reformador
Los Aposentos
Cerro Mira-Mundo
Santa Rosalia
Bahia de Santo Tomas (Bahia de Amatique)
Cuevas del Silvino
Volcan de Pacaya
Ruinas de Iximche
Sipacate Naranjo
Lago de Amatitlan
Lago de Izabal
Lago de Guija
Laguna de Ayarza
Laguna de Atescatempa

and syrphid flies are attracted to the protein hydrolysate in the malathion bait spray (Hagen, et al., 1970). An analysis of insects killed in a protein hydrolysate-baited malathion trap was conducted by Ichinohe et al. (1977) in a small scrub forest surrounded by sugar cane fields. By insect order, the most prevalent insects killed were Diptera (flies, etc.), Blattaria (roaches), Hymenoptera (bees, wasps, and ants), Psocoptera (psocids), and Coleoptera (beetles). Melon flies, relatives of the Medfly, constituted 20% of the dipterans, while ants accounted for 97% of the hymenopterans. It is difficult to draw conclusions from the study because of the disparity between its conditions (unlimited exposure to the material in traps for nontarget insects) and the conditions that would be encountered under actual field applications (small amounts of pesticide in unconfined areas).

Numerous researchers have reported that malathion bait spray frequently is more harmful to beneficial insects involved in biological control than it is to the insects being controlled. One such study reported the outbreak of an otherwise-controlled plant feeding insect due to the drastic population reduction of beneficial insects parasitizing it. The recovery of the population of beneficial insects was enhanced by immigration from surrounding, unsprayed areas (Washburn et al., 1983).

Soil microorganisms (bacteria and fungi) are not harmed by dilute concentrations of malathion, i.e., concentrations used in the Guatemala MOSCAMED Program. Such microorganisms may be inhibited by an accidental malathion concentrate spill, but would quickly recover. Bacteria and fungi are able to degrade and utilize malathion as a carbon and/or phosphate source (Griffiths and Walker, 1970; Daughton and Hsich, 1977).

e. Honey Bees

Malathion in the Guatemala MOSCAMED Program is expected to adversely effect honey bees within the spray areas (table VI-12). A mortality of at least 15% is expected for bees which are 90 meters from the spray application areas during the first 24 hours (tables VI-9 and VI-12). However, bees that visit the application areas 1 day after a malathion application are not at acute risk (table VI-9). Special procedures have been developed to inform beekeepers; refer to the mitigation section for details.

f. Plants

Malathion is used worldwide as a means of eliminating plant pests because of its low phytotoxicity. In Kenya, malathion formulations in Safer's insecticidal soaps are the preferred method to control conifer aphids (Musau and Parry, 1988). In New Zealand, malathion is the preferred insecticide because of its low phytotoxicity and mammalian toxicity (Dennis, 1978). Australia uses malathion with carbaryl as a disinfectant for imported cut flowers, plants, or parts (Turner et al., 1984). In the southeastern United States, pecan trees are treated with malathion at 0.81 lb/100 gal (Payne et al., 1977). Rumania specifies the American formulation of malathion for cereal crops because of its efficiency and lack of phytotoxicity (Pasol et al., 1978).

Seedlings of 10 crop plants were tested with 21 organophosphates and malathion was shown to be slightly phytotoxic when applied at 200 to 500 ppm/plant (Ishitani et al., 1975). Malathion is used at a rate of 4 g/liter and applied at 20 ml/plant for cucumber, melon and gourd (Dennis, 1978). Malathion is not phytotoxic to cucumbers (Mote, 1976) nor sweetpotato (Schalk, 1990).

Malathion phytotoxicity to forested areas was not seen after application of malathion at 0.72 lb a.i./acre (Giles, 1970). Malathion showed no phytotoxicity toward box elder trees treated between 1973 and 1978 (Drouin and Kusch, 1979). Malathion is not significantly phytotoxic to Boston fern, but permethrin, diazinon, fenitrothion are all phytotoxic (Brewer and Tippins, 1982).

All the aforementioned phytotoxicity studies involved the use of malathion at application rates that exceed the low application rate used in the Guatemala MOSCAMED Program (0.095 lb a.i./acre).

Phytotoxicity by malathion or ethion on guava, hibiscus, *Bischofia javanica* and *Ficus* spp. have been reported (Reinert and Neel, 1977). However, the damage was generally minor, was most intense 1 week after application, and barely visible 4 weeks after application (Reinert and Neel, 1977).

Reports of plant damage due to malathion have been reported for banana and coffee (CICP, 1988). Young banana leaves were reported to be severely burned. Reports on coffee damage ranged from leaf burn and loss, to no effect. These reports of damage were gathered from individual farmers and growers and have not been supported with scientific evidence. Cardamon was not reported damaged.

The Guatemala MOSCAMED Program should not adversely affect bananas because: bananas are not a Medfly host, large plantings will not be treated, bananas are grown in coastal regions where few Medfly host plants are present, and banana growing areas will not be treated by aerial or ground applications.

No scientific evidence has been found which indicates that malathion bait spray applications of the Guatemala MOSCAMED Program have had an adverse effect on coffee.

Phytotoxicity has been reported on various crops when malathion is mixed with other insecticides or herbicides (Kirby and Santelmann, 1973; Campbell and Penner, 1979). However, not all mixtures of malathion and other insecticides are phytotoxic (Campbell and Penner, 1979; Stephenson et al., 1980; Turner et al., 1984). McConnell and colleagues (1985 and 1987) have shown that use of plant growth regulators with malathion or other insecticides increases the phytotoxic effect, whereas antitranspirants do not affect phytotoxicity.

In conclusion, no significant adverse effect on Guatemalan vegetation is anticipated because of: the relatively low phytotoxicity of malathion, the program's low application rate, and the selective targeting of Medfly host crops.

g. Potential Influence on Biological Diversity

Few carefully documented studies have been conducted on the affect of pesticide application on biological diversity, but one distinct change that occurs after pesticide application is a simplification of the species complex (Thompson and Edwards, 1974). This simplification is seen in both terrestrial and aquatic environments. An initial decrease in species numbers was attributed to aldrin soil application (Edwards, 1969), but many of the eliminated species recolonized the treated areas or new species appeared to occupy vacant niches. There are numerous reports that, in freshwater treated with pesticides, total individual numbers reach pretreatment level after 1 year, although species composition may be different (Thompson and Edwards, 1974). Recolonization of treated areas tends to be more rapid in terrestrial environments than in aquatic ones.

In aquatic systems treated with pesticides, invertebrate species recovery is dependent on several factors: (1) the time required to degrade the pesticide, (2) the size of the aquatic body (rivers and streams recover faster than lakes and ponds without river inputs), (3) the replenishment from other aquatic sources, and (4) the stage of the invertebrate species at time of treatment, i.e., pre-pupal or pupal stages.

More pesticide studies have been conducted on terrestrial systems than on aquatic environments (Thompson and Edwards, 1974). In general, organophosphates tend to be toxic to nematode populations in the soil, but these populations are so large that the overall effect is usually very small. Earthworms are not affected by most insecticide doses normally applied to the soil (Thompson and Edwards, 1974). Most organophosphate insecticides do not kill earthworms (Edwards, Thompson, and Beynon, 1968). Soil molluscs (slugs and snails) are extremely tolerant to most pesticides. Exceptions include: carbaryl and phorate (Edwards and Thompson, 1973), and copper sulfate and methiocarb (Thompson and Edwards, 1974).

Mites are very numerous soil predators. The effects of organophosphates on mites are variable. Some investigators have seen population decreases due to organophosphate application (Edwards, Thompson, and Beynon, 1968). However, other investigators have reported mite population increases due to organophosphates (Hyche, 1956; Olivier and Ryke, 1969).

Collembola are very numerous in subsurface and surface soils; many species are unaffected by insecticides (Thompson and Edwards, 1974). As has been seen with mites, organophosphates have extremely varied effects on Collembola populations. Decreases (Abdellatif and Reynolds, 1967) and increases (Edwards, Thompson, and Beynon, 1968) in Collembola populations were reported after organophosphate applications.

Within Myriapoda, pauropods were shown to be sensitive to all insecticides that have been tested against them (Edwards, Dennis, and Empson, 1967), including parathion (Weber, 1953); unfortunately, malathion was not tested. For symphylids, organophosphates are moderately toxic (Edwards, Thompson, and Lofty, 1967). Millipedes' sensitivity to organophosphates is very low and many investigators report that organophosphate insecticides are ineffective against millipedes (Thompson and Edwards, 1974).

The Guatemala MOSCAMED Program is not expected to severely impact the aquatic environment for the following reasons: streams, lakes, and ponds are not to be sprayed in the Guatemala MOSCAMED Program; malathion has been shown to degrade rapidly in aquatic environments; the malathion application rate is low (0.0095 lb a.i./acre); and even though some species are at risk but not eliminated by malathion, freshwater species diversity has been shown to recover. In terrestrial environments, malathion application is not expected to severely impact species diversity because the application rate is low (0.0095 lb a.i./acre), malathion degrades rapidly, many soil invertebrates are tolerant to organophosphates, invertebrate population levels tend to be very large and are easily impacted, and species recolonization has been demonstrated to be relatively rapid. Therefore, the Guatemala MOSCAMED Program is not expected to have any detrimental or long-lasting effects on biological diversity in either the aquatic or terrestrial environments.

5. Water Quality

There appears to be little risk that the Guatemala MOSCAMED Program would result in an adverse environmental effect on water quality. Although applications of agricultural pesticides have the potential to affect surface and ground water as a consequence of contamination resulting from drift, runoff, or leaching, program mitigations have been designed specifically to protect water and water quality in Guatemala.

Program mitigations include: (1) the provision of aerial no-treatment buffer zones within 200 meters of any recognized bodies of water, (2) the marking of buffer zones with aerial markers such as balloons or kytoons, (3) the prohibition of chemical treatments (aerial or ground) during the rainy season (approximately May to October), (4) the prohibition of aerial application if the wind exceeds 10 mph, (5) the use of helicopters in areas of rough terrain to precisely target the applications, (6) the use of alternative techniques in or around sensitive areas, and (7) the use of spray-sensitive cards to verify accurate targeting of applications.

The limited persistence of malathion in natural waters also reduces the likelihood of adverse effects on Guatemala's water quality. The pH (a measurement of relative acidity) of Guatemalan lakes ranges from neutral or 7.0 to slightly alkaline at 8.6, with most measured values between 7.5 and 8.0 (Brezonik and Fox, 1974). Malathion persistence in water is strongly influenced by temperature and pH (Wolfe et al., 1977). The persistence of malathion is greatest at pH 4 in cold water (^{o}C). The half life in water at 25^{o}C is 18 weeks at pH 4.5 compared to a half week at pH 8 due to alkaline hydrolysis (Chapman and Cole, 1982). Based on the warm temperatures and slightly alkaline pH of Guatemalan lake waters, malathion would not be expected to persist for a great length of time within those waters. The persistence of malathion is further described in table VI-13.

In the Medfly Eradication Program in California in 1990, water samples were taken from pools and ponds which received direct applications of malathion bait spray (California Department of Food and Agriculture (CDFA), 1990). No mitigations or protective measures were taken for those water bodies. The measured concentrations of malathion varied from 3.6 to 90 ppb for these samples. For the Guatemala MOSCAMED Program, the potential concentrations would be expected to be considerably less than these already low concentrations.

The large droplet sizes (45-1745 microns) of the malathion bait spray (CDFA, 1990) are believed to have less potential for drift than the smaller droplets from conventional ultra low volume (ulv) applications. The prohibition of aerial application if the wind exceeds 10 mph also serves to reduce drift and subsequent contamination of water bodies.

Thus, based upon the measured low concentrations of malathion in water under actual field conditions in a similar program and upon the protection afforded by specific program mitigations, the Guatemala MOSCAMED Program is expected to have no significant adverse environmental effect upon water or water quality.

6. Air Quality

The potential impacts of the Guatemala MOSCAMED Program activities on air quality include slight increases in fugitive dust from wind erosion of disturbed soils and slight increases in concentrations of criteria pollutants from the internal combustion engines of the vehicles, airplanes, and machinery used in control operations. Criteria pollutants are those air pollutants for which maximum allowable emission levels from fuel combustion and ambient air concentrations have been set by the U.S. Environmental Protection Agency. The small amount of these pollutants should have a negligible effect on air quality.

The use of malathion is not expected to adversely affect air quality. The vapor pressure of malathion at 20-25°C is 1.25×10^{-4} mm Hg (Dobroski and Lambert, 1984). Since malathion has a low volatility coefficient, significant amounts of malathion would not be present in the atmosphere. Photolysis rates are too slow to be of environmental significance (Wolfe et al., 1977). None of the activities of the Guatemala MOSCAMED Program are expected to significantly affect air quality.

7. Noise

The effects of application aircraft noise and presence on humans and other nontarget species has been considered. Since application aircraft are only in an area a few days, do not repeatedly treat the same areas, and seldom operate for more than a few hours per day, any disturbance to humans or other nontarget species is minimal and temporary. Low-flying helicopters

TABLE VI-12. MORTALITY OF CAGED HONEYBEE *Apis mellifera* BY MALATHION AT VARIOUS DISTANCES FROM APPLICATION SITE

Distance from sprayed area (m)	% mortality at 24 hours	
	ULV[a] (426 g/ha)	EC spray[b] (134 g/ha)
15	68.3	100.0
30	39.0	65.5
60	0.6	43.0
90	0.3	15.0

[a]ULV - ultra low volume.

[b]EC - emulsified concentrate.

Adapted from Caron, 1979.

TABLE VI-13. PERSISTENCE OF MALATHION IN WATER UNDER LABORATORY CONDITIONS[a] AND IN RIVER H_2O[b]

Period		Malathion	
(hr)[a]	(wk)[b]	(ppm)[a]	(mg/L)[b]
0	0	2.00	10.0
24	1	1.20	2.5
48	2	<0.27	1.0
72	4	nd[c]	0.0
96	8	nd[c]	0.0

[a]Tap water pH 8, temperature 35°C, and 64 foot-candles incident light at the water surface.

[b]Little Miami River, pH 7.3 to 8.0.

[c]nd = not detected.

Adapted from Mulla et al., 1981.

are used intermittently by wildlife biologists to survey and observe endangered bird species, with no apparent ill effects to those species. Commercial aircraft that may transit the area fly too high to have an effect, and therefore would not constitute a valid comparison.

8. Potential for Unavoidable Environmental Impact

No potential for unavoidable environmental impact has been determined. The preferred integrated control alternative affords the maximum flexibility for selection of control methods to meet specific environmental conditions. Also contributing to the lack of potential for unavoidable environmental impact are the program's routine operational procedures and the specific mitigation measures.

9. Potential Cumulative Impacts

Cumulative impacts are those impacts that result from the incremental impact of the program action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts may result from direct effects which are caused by the action and occur at the same time and place, or they may result from indirect effects which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.

The primary concern for cumulative impacts in the Guatemala MOSCAMED Program relates to potential effects of the chemical insecticide malathion. Direct effects related to use of malathion and its environmental accumulation and bioaccumulation were considered. No environmental accumulation or bioaccumulation is foreseen for program use of malathion. The history of the eradication effort in Guatemala illustrates the progressive nature of the program—as the eradication area expands, the likelihood decreases that those previously eradicated areas will require retreatment, and the potential for treatments to impact each other is reduced. Malathion is degraded in the natural environment through the process of hydrolysis, yielding non-toxic intermediates (Pascal and Neville, 1976). The interval between expected treatments is such that no residues of malathion from previous applications would remain or have the potential to exacerbate the risk of subsequent applications.

Potential environmental consequences, including both direct and indirect effects of the program on human health, have already been described. Adherence to the required safety precautions and mitigation measures minimizes the potential for cumulative impacts on human health. Those procedures result in good margins of safety relating to exposure to program use of malathion. In order for cumulative impacts resulting from combined program use of malathion and non-program commercial use of the same or other pesticides, the additive effects would have to substantially exceed the potential effects of the program in order to result in any unacceptable margins of safety.

Information about other pesticide usage in Guatemala is limited (Rafael Landivar University, 1984). Some concern may exist for the cumulative effects of program pesticides in combination with non-program pesticides such as chlorinated pesticides which have been regularly detected in meat and milk. Although DDT use is prohibited in Guatemala, DDT residues continue to be detected in analyses of meat. No efforts to control organophosphate residues in foods were begun in Guatemala until 1989. The effects of multiple exposures to chemicals are usually less than additive. At low exposure levels, the potential interaction of the chemicals probably will be nothing more than the independent action of the individual chemicals because the receptor sites and transport systems will not be saturated (EPA, 1984). Exposure to DDT plus malathion actually results in an antagonistic or protective effect (Keplinger and Deichmann, 1967). No significant synergistic or cumulative effects are anticipated provided all usage complies with standard precautionary procedures and mitigations established for the program.

Exposure to chemicals can lead to allergy, hypersensitivity, and hypersusceptibility (EPA, 1984; DOT, 1980; Calabrese, 1978). Effects such as hypersensitivity often depend on cumulative or multiple exposures. High risk groups that are hypersusceptible to organophosphate pesticides include: individuals with immature enzyme detoxification systems (embryos, fetuses, neonates, and children to 3 months of age), pregnant females, individuals with highly sensitive cholinesterase variants, individuals low in dietary protein, individuals with liver disease, alcoholics, and drug users. All people at some time during their lives are at increased risk to one or more commonly encountered environmental contaminants. In order to minimize exposure for individuals who could be sensitive or become sensitive to malathion, program operational procedures are designed to protect sensitive areas and provide public notification of planned aerial applications.

Some mortality of beneficial insect species might be expected as a consequence of the malathion applications. This effect is expected to be only partial and temporary for several reasons, including: (1) the relative nonattraction of the bait for species other than Medfly, (2) the strip applications commonly employed which leave much habitat untreated, (3) the targeting of only Medfly host plants for treatment, and (4) the relatively rapid degradation of malathion in the natural environment. The disadvantage incurred through a temporary reduction of those beneficials must be weighed against the advantages of Medfly control, especially if eradication is considered.

The characteristics of the treatment areas further reduce any potential for cumulative effects on nontarget organisms. The treatment areas of the Guatemala MOSCAMED Program are primarily commercial coffee plantations and fruit orchards. Coffee is generally grown under the shade of a cultivated overstory tree, *Inga* sp. Coffee growers maintain the canopy of this species at about 7 meters above the ground. A portion of the aerially applied malathion bait adheres to the *Inga* sp. overstory in the coffee plantations and to the overstory in the fruit orchards, with consequential reduction in the exposure to nontarget organisms (particularly ground-dwelling organisms) in the understory. The use of strip applications and the unique conditions associated with the overstory vegetation present in plantations and orchards combine to provide ample untreated habitat for the maintenance of nontarget species populations.

Heavy Medfly populations can reduce the market potential of an infested crop, resulting in a poor return for investment. Alternately, the control or elimination of Medfly from a host crop could result in economic growth and increases in crops. For wildlife species that subsist in part on Medfly host produce, a direct result of the program might be an improved chance of survival.

No potential cumulative effects are foreseen for endangered or threatened species of Guatemala because of the operational characteristics of the program (e.g., strip treatments, treatments of Medfly host environments only, and no treatment of aquatic areas), its safety procedures, and mitigation measures. Species which depend on insects for their food source should not be adversely impacted, and would continue to have an ample food supply due to the specificity and targeting of the treatments.

Indirect effects which were considered include the effects of additional commercial insecticide usage in farmland adjacent to or within Guatemala MOSCAMED Program areas, and the effects of unforeseen environmental factors on the fate of insecticides and their resultant impact on nontarget species. Guatemala MOSCAMED has no control over commercial pesticide usage for this or any other target pest on privately owned land, but no significant synergistic or cumulative effects are anticipated provided all usage complies with labelling and standard precautionary procedures. Certain unforeseen environmental factors such as heavy rains and flooding could tend to temporarily "trap" malathion in a body of water inhabited by aquatic wildlife. This would be a rare occurrence, since insecticide applications are not permitted under adverse weather conditions and a 200 meter buffer is required around all recognized bodies of water. In such an unusual case, the relatively rapid degradation of malathion would greatly reduce the potential for sustained damage to nontarget species. In actuality, there would be no advantage to insecticide applications under adverse weather conditions due to lack of efficacy.

In conclusion, use of malathion according to Guatemala MOSCAMED Program operational procedures should not constitute a significant cumulative impact on the quality of Guatemala's environment.

10. Program Evolution and Reduction of Environmental Risk

Frequent operational reviews of the ongoing Guatemala MOSCAMED Program have shown that it has not had an identifiable adverse impact on the quality of the human environment, including human health, nontarget species, or the physical environment. These operational reviews have provided guidance and a basis for improvement in the program.

In addition to the Guatemala MOSCAMED Program's own internal reviews, another independent review of the program was undertaken by the Consortium for International Crop Protection (CICP) for the United States Agency for International Development (USAID). This organization prepared an environmental impact analysis (EIA) to determine feasibility of USAID support through Public Law 480 Title I (Local Currency) funding (CICP, 1988). Where potential risks or deficiencies were identified, immediate corrective action was taken to reduce potential exposures to pesticides and resulting risk. In order to provide a perspective of the types of program decisions made as a consequence of the internal and external reviews of the Guatemala MOSCAMED program, selected decisions are summarized within this section.

Protection of Guatemala MOSCAMED Program workers from pesticide exposure has always been of concern to APHIS. Some concerns were raised in the CICP, EIA about the training required for Guatemala MOSCAMED Program workers, availability of safety equipment, and employee negligence in the proper use of protective gear. As a consequence, affirmative program action has provided additional guidance to ensure that program guidelines are followed. All pesticide applicators and other workers with potential for exposure to pesticides (mixers, loaders, airplane flaggers, and fruit strippers) are trained in the proper use of pesticides (including storage, transportation, application, disposal, emergency procedures, and appropriate protective clothing). Pesticide safety equipment is provided to all workers who could receive potential exposure. Rubber or neoprene gloves are required for workers during mixing and loading operations. Soap and water are available to mixers, loaders, and applicators at all times.

Some specific concerns were raised about pesticide use in quarantines. Mandatory treatment with propoxur and dichlorvos of vehicles passing through quarantine stations was discontinued in April 1988 (CICP, 1988). Formulations of these pesticide were completely replaced by the use of d-phenothrin, a less toxic chemical. Instructions for respirators and replacement cartridges used in the fumigation of regulated quarantine commodities are provided by the manufacturer in the English language only. Program managers now ensure that all workers fully understand the proper way to use these respirators.

The fumigation chambers used by the Government of Guatemala to treat commodities in fulfillment of other countries certification requirements are fully enclosed and designed to prevent leakage and resultant human exposure. Regular inspection of these chambers through pressure testing and vacuum checks is done. The fumigant dispensing system is designed to accurately measure and dispense the exact amount of methyl bromide to the fumigation chamber. It is a closed system that precludes direct contact with the fumigant. The use of ethylene dibromide (EDB) was discontinued several years ago as a consequence of concerns over potential health hazards associated with the use of this chemical. Halide detectors are used to test seals of chamber doors, around chimneys, and around fumigant dispensing systems to ensure that no leaks occur. Respirators are required for all workers entering fumigation areas while fumigations or aerations of the fumigation chambers are in progress. These workers would enter the fumigation areas only to dispense methyl bromide fumigant into the chambers at the start of fumigations, to use halide detectors to check for leaks of fumigant, or to start up the fans for aeration at the conclusion of fumigations. The fumigation chambers are designed to have a complete exchange of air within one minute. Four complete changes of air are considered adequate for complete aeration. The Government of Guatemala requires at least 45 minutes of chamber aeration at the conclusion of the fumigation. After this period of time, there is clearly no further emission of methyl bromide and complete aeration poses no hazard to a worker without a respirator. The fumigation chambers are padlocked during fumigations and at times when quarantine commodity treatments are not being conducted. This is a safety precaution now taken to restrict the use of these chambers to quarantine fumigations only.

Guatemala MOSCAMED Program workers regularly exposed to pesticides are required to have periodic plasma cholinesterase testing to monitor for potential pesticide exposure. The cholinesterase monitoring provides a baseline which enables health workers to distinguish between potential effects of pesticide exposure and other nonspecific health problems caused by amebic dysentery, parasitic diseases, and other illnesses. The baseline levels additionally provide a perspective for evaluation of general health levels of workers, enabling program managers to identify workers who might be at greater risk due to cumulative effects of pesticide exposure. Individual susceptibility to the toxic effects of the bait spray cannot be specifically predicted from the current state of knowledge. It is generally accepted that the normal margin of safety of 100 for interspecies and intraspecies variation is sufficient to ensure that most people will experience no toxic effects. However, unusually sensitive individuals may experience toxic effects, whereas the average person would not. Sensitive individuals constitute only a small fraction of the population at large. Cholinesterase monitoring of the program has shown only three workers (2%) who exhibited low cholinesterase activity (CICP, 1988). Only one of these workers was involved with program pesticide applications. Program managers now assign workers accordingly to prevent exposure to any Guatemala MOSCAMED Program workers found to be sensitive to malathion bait spray. Public notification of the time and place of aerial application will be provided in advance of treatments. This will allow any known sensitive individual of the general public to remain indoors or in an area where no pesticide exposure will occur.

Program review has resulted in additional protective measures being established for sensitive sites (reservoirs, lakes, parks, schools, churches, hospitals, recreation areas, etc.). These sites are identified and maps that accurately show the location and borders of these sites are now provided to all program staff. Aerial balloons are placed to indicate the buffered area around these sites where necessary. Monitoring is conducted through the use of bait-sensitive cards to check for drift. There is a 200- meter buffer placed around any recognized body of water. This prevents water contamination and exposure of nontarget aquatic organisms. Aerial applications are not made into canyons where water contamination is a concern. When circumstances do not permit aerial application, program managers avail themselves of approved appropriate control alternatives. These may include ground applications directly to host plants, cultural control, and/or mechanical control followed by the release of sterile insects.

The protection of plants from phytotoxic and other potential negative effects of bait spray has also been carefully considered. The decision to restrict both aerial and ground applications to Medfly host environments restricts the potential range of plants which could receive exposure. Applications of the malathion bait spray at the required application rates for this program have not been shown to cause phytotoxicity to the host crops. The strip applications, prohibition of application at the time of host crop flowering, and other mitigations for pollinators assure that control methods will not adversely impact pollination of crop resources and natural flora.

One area of frequent concern to local agriculture is the exposure of honey bees and other pollinators to malathion bait spray. Program protective measures have been established for pollinator species, although analyses done for the CICP's EIA of honey bees in hives adjacent to treatment areas were highly variable and inconclusive. The CICP team attributed their lack of definitive results to other factors such as the presence of tracheal mites in every colony, prevalence of Nosema disease, prevalence of American foulbrood, and the lower honey yield of the Africanized honey bees which now occupy an estimated 50% of the apiaries in Guatemala. The malathion bait spray was not shown to attract honey bees, even when placed in containers 2 meters from hives for 2 days (CICP, 1988).

Aerial spraying will be done in alternate strips to limit the exposure to these non-target species. Low application dosages and large malathion bait spray droplets will be used in these applications. Beekeepers will be given a 7 day notice in advance of aerial applications and advised to confine their bees in hives covered with burlap during the day of application. Treatments will be restricted principally to Medfly host crops in both ground and aerial applications. Treatments will not be made to host crops of Medfly when in bloom to prevent exposure of pollinators. A 150 m radius buffer zone will remain untreated around all apiaries with 20 or more hives. Cards sensitive to malathion baitspray (dye cards) will be placed in these sensitive areas to detect any drift and to ensure that any observed mortality to bees in the apiaries is not the result of direct exposure to aerial applications. The overstory of trees in the orchards and coffee plantations provides a physical barrier which reduces potential exposure below the canopy. This canopy provides some natural protection to pollinators in the understory. The physical features of the canopy in aerial treatment flight patterns and the practice of strip applications will ensure that untreated areas remain in all habitats for protection of pollinators and non-target wildlife. This enables the preservation of the natural biological diversity of the host crops, with their associated natural biological controls.

Integrated control of a pest species is accomplished through an adaptive and responsive process designed to reduce the potential for environmental risk. Some decisions can be made for an entire program, but the local program manager is responsible for careful analysis of local environmental conditions to determine the best control alternatives and for securing the safest possible working conditions for program personnel. The current integrated approach of the Guatemala MOSCAMED Program provides the program manager with several control alternatives to conduct an effective eradication program that is safe for the human environment and the program workers.

VII. Program Mitigative Procedures

A. Mitigation Background

The mitigative procedures which have been developed for the Guatemala MOSCAMED Program reflect the concern of the Guatemala MOSCAMED Program and APHIS for protecting and conserving environmental quality within Guatemala. The rationale for the mitigation procedures employed by the program is summarized in this section, which also contains a concise compilation of the mitigation procedures to be used in the program.

The program will use as one of its component alternatives the application of malathion, an insecticide commonly used for agricultural purposes worldwide. This insecticide, characterized by low mammalian toxicity, will be used in a controlled manner which has been calculated to reduce environmental risk and exposure to nontarget organisms. Potential consequences of any pesticide treatments include those arising from unintentional exposure through insecticidal drift, inadvertent application outside designated treatment areas, and accidental spills. To minimize such effects, Guatemala MOSCAMED has gone to significant lengths in the development of training, operational procedures, and mitigative procedures. Sensitive areas within the vicinity of treatment areas will be identified, marked, and evaluated with respect to use of alternative control technologies. In the unlikely event that an accidental spill of insecticide occurs, established procedures provide for efficient and safe containment and elimination of the spill.

A comprehensive training program has been implemented by Guatemala MOSCAMED staff to train and maintain competency of their personnel relative to application procedures, safety precautions, and adherence to established mitigative procedures. The diversity of Guatemala's human population, with over 30 different native languages (most not mutually understandable) and the low adult literacy rate in Spanish (40%) result in special needs for program personnel in the training of its own personnel and the protection of the public. In addition to use of person-to-person contacts, the Guatemala MOSCAMED Program has developed training materials based on Spanish, which also include pictorial representations specifically designed to overcome language barriers. One example of those training materials, designed to educate beekeepers, is provided in appendix 7.

Protection measures have been designed to ensure the conservation of Guatemala's nontarget plants and animals. Many of Guatemala's endangered and threatened species live within areas which are remote or are not targeted for Medfly eradication treatments, and therefore would not be affected by any aspect of the program. When an endangered or threatened species exists within a proposed treatment area, the Guatemala MOSCAMED Program will employ protective measures established for that species, as discussed in appendix 8. Some aquatic invertebrates which may constitute an important component of aquatic food chains are highly susceptible to the program insecticide malathion, and may need to be protected. Mitigative procedures provide the required protection by means of a buffer zone around recognizable water resources. Many plants, including important crop plants, rely upon insects for pollination. Protection of pollinators is an economic consideration for crops, and there are legal and social implications which must be considered with regard to protection of pollinator species. The Guatemala MOSCAMED Program has addressed these concerns through a series of mitigative measures involving application procedures, protective buffer zones, and technical advice and assistance, as appropriate.

Lastly, in order to ensure that the mitigative procedures have achieved their desired goals, MOSCAMED has developed a comprehensive monitoring plan which will specifically assess concerns with regard to public safety and health, proper application of pesticides, and protection of nontarget species including pollinators.

B. Mitigative Measures—All Program Procedures

1. All applicable environmental laws and regulations will be followed.

2. All materials will be applied with appropriate concern for their potential impact on the endangered and threatened species identified in this document.

3. Sensitive areas (reservoirs, lakes, parks, schools, churches, hospitals, recreation areas, etc.) that may be near or adjacent to treatment areas will be identified. The program will utilitze appropriate control alternatives to ensure that these areas are not adversely affected.

4. Environmental monitoring of the program will be in accordance with a current environmental monitoring plan.

5. Only Medfly host environments meeting the program criteria will be treated.

6. All program personnel will be instructed on procedures and the use of equipment and materials. Field supervisors will emphasize these procedures and monitor the conduct of personnel.

7. Procedural information and safety techniques for workers will be prepared and presented both in Spanish and pictorial format. This will address communication difficulties due to the numerous indigenous languages spoken in Guatemala.

C. Chemical Applications

1. All materials will be applied in strict accordance with label instructions.

2. All mixing, loading, and unloading will be in an area where an accidental spill will not contaminate a stream or other body of water.

3. Any insecticide spills will be cleaned up immediately and disposed of in a manner consistent with the laws governing such situations in Guatemala.

4. All pesticides will be stored in accordance with local regulations. Pesticide storage areas will be inspected periodically.

5. All program personnel will be instructed on emergency procedures to be followed in the event of insecticide exposure. Equipment necessary for immediate washing procedures will be available.

6. Applicators of chemical pesticides will be required to have periodic cholinesterase testing.

7. All APHIS employees who plan, supervise, recommend, or perform pesticide treatments are also required to know and meet any additional qualifications or requirements of the countries where they perform duties involving pesticide use.

8. Pilots, loaders, and other personnel handling insecticides will be advised to wear safety equipment and protective clothing.

9. Unprotected workers will be advised of the respective re-entry periods following treatment. For malathion, workers should not re-enter the field until the material has dried.

D. Aerial Applications

1. Prior to beginning operations, aerial applicators will be briefed by MOSCAMED staff regarding operational procedures, application procedures, treatment areas, local conditions, and safety considerations.

2. Aerial application sites will be inspected prior to any treatment to determine the presence and nature of sensitive areas. In cases where aerial applications would result in an unacceptable potential risk to a sensitive area, the program manager(s) will determine the need for approved alternative controls, as described in this analysis.

3. Program planning for treatment blocks will be done far enough in advance to facilitate notification of the public.

4. Flags or other markers will be used in areas without natural landmarks for pilot guidance.

5. No aerial chemical applications will be made within 200 meters of any recognized body of water. With treatment of alternate swath rows, this

frequently results in buffer zones which are even larger than the minimum 200 meters. When necessary, aerial markers are placed to indicate the buffer zones around water bodies. Aerial chemical applications will not be made into canyons where water contamination is a concern.

6. Applications are made by helicopters in areas with rough terrain. This enhances accurate placement of controls and increases the safety of applicators.

7. Aerial chemical applications will not be made in areas occupied by workers.

8. To the degree possible, insecticides will be delivered and stored in sealed bulk tanks, and then pumped directly into the aircraft.

9. Aerial applications will not be made when any of the following conditions exist in the treatment area: wind velocity exceeds 10 mph, rain is falling or is imminent, weather is foggy, air turbulence exists that could seriously affect the normal spray pattern, or temperature inversions exist that could cause offsite movement of spray. These practices reduce the potential for runoff and drift of aerially applied chemicals.

10. In order to further reduce potential for runoff of aerially applied chemicals, applications will not be made during the rainy season (approximately May to October).

11. Program personnel will use cards sensitive to malathion bait (dye cards) to determine swath width during calibration and monitoring. Dye cards are used in monitoring to validate swath width and droplet size, and for evaluation of the potential for drift.

E. Ground Applications

1. Ground applications of chemical pesticides will be made to Medfly host environments only.

F. Special Measures for Protection of Pollinators

1. Honey Bees

a. MOSCAMED will provide a 7-day warning to beekeepers before applications are made to an area where they are known to maintain apiaries.

b. MOSCAMED will notify beekeepers of scheduled program treatments, procedures, protective measures, and available assistance. MOSCAMED will acquire and maintain a listing of active beekeepers in the treatment areas.

c. Protective measures for bees will be prepared for beekeepers by MOSCAMED in Spanish, and also in a pictorial format which could be understood by illiterate workers. This would also increase the understanding of indigenous people who speak any of the numerous languages in Guatemala.

d. Beekeepers will be advised by MOSCAMED to confine their bees in hives covered with burlap during the day of application.

e. MOSCAMED will make available technical advice and assistance to beekeepers. Assistance to beekeepers will include: burlap (or comparable material) to cover hives, sugar to mix with water as food for confined bees, and pollen (when approved by MOSCAMED entomologists).

f. To minimize potential for contamination of items provided to beekeepers by MOSCAMED and resulting risk to bees, the materials provided to beekeepers for use with their apiaries will be stored separately from pesticides used in the MOSCAMED project.

g. MOSCAMED will observe a chemical no-treatment buffer zone (aerial and ground applications) of 150 m radius around apiaries with 20 or more hives. Aerial and ground applicators will be notified of the locations and boundaries of the buffer zones.

Boundaries of no-treatment buffer zones will be marked with aerial balloons or kytoons. Olotes will be placed throughout the buffer zones surrounding apiaries at the recommended density.

h. MOSCAMED and notified beekeepers will enter into agreement regarding program responsibilities and jointly will sign a formal memorandum of understanding which details the rights and responsibilities of both parties. (See Appendix 7, Memorandum of Understanding, MOSCAMED Program-Beekeeper.)

2. Euglossine Bees, and Other Pollinators

a. Aerial strip coverage (100 meters in width) using malathion bait spray will minimize impact on euglossine pollinators in coffee growing areas which contain identified populations of endangered species of orchids (see section V, Control Alternatives, for description of chemical control alternative).

VIII. Monitoring

The "Environmental Monitoring Plan—Guatemala MOSCAMED Program" establishes procedures and criteria for environmental monitoring of the program. Samples will be collected, analyzed, and evaluated for three major categories: programmatic, sensitive site, and complaint/emergency. The monitoring plan is incorporated by reference into this analysis; refer to appendix 6 for a comprehensive description of the environmental monitoring which is a part of this program.

IX. Laws Affecting the Moscamed Program

A. Guatemalan Law

Guatemalan environmental legislation is based upon several different laws. Basic authorities are found in the Constitution of Guatemala and the powers accorded to the Government agencies. However, the mechanisms for protecting the environment of Guatemala are often unclear and not a part of existing laws.

The Constitutional Convention of May 31, 1985, has determined a need for specific environmental legislation—the Mark Law, Frame or Organic Law of the Environment. Article 97 states, "The State, the municipalities and the inhabitants of the national territory are obligated to participate in the social, economic, and technical development to prevent environmental contamination and to maintain the ecological equilibrium. The necessary norms will be dictated to guarantee that the use and taking advantage of the fauna, flora, land, and water will be rational, avoiding waste."

Guatemala has no specific law requiring environmental analysis for programs such as the Guatemala MOSCAMED Program, nor are the specific needs for such an analysis covered in any environmental law. However, Guatemala's Law of Protection and Improvement of the Environment, Article 8, states that: "For all project, work, industry, or other kinds of activity that by their characteristics can produce deterioration of the environment's renewable or non-renewable natural resources, or introduce harmful or obvious modifications to the countryside and the cultural resources of the national patrimony, a study evaluating the environmental impact will be necessary before its development, to be performed by technicians in the field and approved by the National Environmental Commission."

The Guatemala Environmental Law, Article 25, stipulates the functions of the technical consultants: "To recommend and supervise the studies evaluating the environmental impact to people, companies, or public or private institutions to determine the best options that permit sustained development."

The "Regulator Law of Importation, Formulation, Storage, Transportation, Selling, and Use of Pesticides (Decree 43-74 of the Congress of the Republic)" regulates use and storage of pesticides in Guatemala.

The General Regulation on Hygiene and Security in Work of the Guatemalan Institute of Social Security's General Regulation on Hygiene and Security in Work, Article 94 (Subsection f) states that "managers are obligated to provide the workers with, depending on the type of work: suits or special equipment for the work, when health and the physical integrity of the worker is in danger . . ."

Based upon review of applicable Guatemalan law, the Guatemala MOSCAMED Program adheres to the standards for protection of the environment of that country.

B. United States Law

Laws of the United States which apply to the Guatemala MOSCAMED Program are principally those same laws which provide the authority for United States federal participation in the program or govern U.S. actions abroad (see section III.D). They include the Organic Act of 1944, the National Environmental Policy Act, and Executive Order 12114.

Section 102(b) of the Organic Act of 1944 (7 USC 147a(b)) authorizes the Secretary of Agriculture to cooperate with the governments of Western Hemisphere countries in control operations in those countries to detect, eradicate, suppress, control, and prevent or retard the spread of plant pests.

APHIS has published guidelines for implementing the procedural provisions for the National Environmental Policy Act (NEPA) (see 44 FR 50381-50384, 51272-51274). These guidelines comply with the Council of Environmental Quality (CEQ) regulations for NEPA implementation (see 40 CFR Parts 1500-1508) and applicable U.S. Department of Agriculture regulations (see 7 CFR Part 1B and 1C).

Executive Order 12114 of January 4, 1979, entitled "Environmental Effects Abroad of Major Federal Actions," furthers the purpose of the National Environmental Policy Act and "represents the United States Government's exclusive and complete determination of the procedural and other actions to be taken by Federal agencies to further the purpose of the National Environmental Policy Act with respect to the environment outside the United States, its territories, and possessions."

Additionally, the Federal Food, Drug, and Cosmetic Act (FFDCA) governs pesticide residue levels acceptable in imported food. FFDCA therefore sets malathion and methyl bromide residue standards applicable for Guatemalan produce imported into the United States. It prohibits importation unless tolerances have been established.

X. Conclusions

The Mediterranean fruit fly is an economically significant pest in Guatemala, and poses a serious threat to the agricultural economy of Mexico and the United States. APHIS and the Governments of Mexico and Guatemala have jointly implemented a plan to eradicate the Medfly from Guatemala. This analysis provides a comprehensive consideration of alternative program strategies and controls, unique characteristics of the Guatemalan environment, potential environmental consequences, mitigation of environmental impacts, and applicable environmental law. It incorporates by reference the Economic Analysis of the Medfly Program in Guatemala, (USDA, 1989) the Cooperative Agreement between the Guatemalan Ministry of Agriculture and APHIS, and the Environmental Monitoring Plan—Guatemala MOSCAMED Program.

The following program alternatives were considered: no action, the Isthmus of Tehuantepec stable barrier zone, and eradication of Medfly from Guatemala. Control alternatives considered were: no action, sterile insect technique, chemical control, cultural control, biological control, regulatory control, integrated control, and miscellaneous controls. The preferred alternative combines the program alternative of eradication of Medfly from Guatemala with the control alternative of integrated control. Integrated control would utilize one or more control methods in a given area in a systems approach on the basis of anticipated economic, ecological, and sociological consequences. It affords the best combination of program efficacy and environmental soundness. Integrated control in the Guatemala MOSCAMED Program would use the following control alternatives as described in this analysis: the sterile insect technique, chemical control, cultural control, and regulatory control.

Unique aspects and potential consequences to Guatemala's environment were considered within the analysis. No significant adverse environmental consequences of the program are foreseen for humans, including MOSCAMED workers and the public, due to the program's routine safety procedures and specially established mitigative procedures. No significant adverse environmental effects are anticipated for other aspects of the human environment, including water quality, air quality, or noise.

Potential environmental consequences to nontarget terrestrial and aquatic wildlife species were also considered. Wildlife are generally protected from adverse environmental effects by program design, areas of operation, and standard mitigation as described in section VII. The risk analysis confirms risk for some species, such as the black howler monkey, bluegill, and green sunfish; however, those species will be further protected from exposure to program pesticide through program operational procedures and specific mitigative procedures. Invertebrate species also are not expected to be significantly impacted; specific mitigative procedures will be taken to advise beekeepers of projected program treatments and advise them of protective measures for their bees. No significant adverse environmental consequences are anticipated for endangered, threatened, or sensitive species of Guatemala. No adverse effects on the biological diversity of Guatemala are foreseen as a consequence of the program.

The program constitutes no potential for unavoidable environmental impact; such potential is negated through a combination of the preferred integrated control alternative, routine operational procedures, and mitigative measures. No direct or indirect cumulative effects are foreseen as a consequence of the program.

The Guatemala MOSCAMED Program is important (for economic as well as environmental reasons) to Guatemala, Mexico, and the United States. Damage to crops in Guatemala will approximate $176 million between 1987 and 1996, with a corresponding cost increase of fruit and vegetables to consumers. Unless there is a coordinated effort to eradicate the Medfly, it will slowly expand its territory, the quality and quantity of produce will diminish, and pesticide usage could increase with resultant adverse environmental consequences.

The success of the program and its technology was demonstrated, first in Mexico and now in Guatemala, with no significant effects on humans or their environment. Achievement of the program goal, the eradication of Medfly from Guatemala, will have a profound beneficial effect on humans, their economy, and the quality of human life.

Appendix 1. References

Abdellatif, M.A., and Reynolds, H.T., 1967. Toxic effects of granulated disulfoton on soil arthropods. J. Econ. Entomol. 60:281.

Allen, R.P., 1952. The whooping crane. New York, NY: National Audubon Society.

Ames, O., and Correll, D.S., 1952. Orchids of Guatemala. Fieldiana: Botany. vol. 26(1):23-24, 412-414, and 556-557.

Anonymous, 1989. Organophosphorus insecticides: A general view. Environmental Health Criteria, International Programme on Chemical Safety. World Health Organization, Geneva, 63, 181 p.

Bazzy, D., 1986. Guatemalan refugee children: conditions in Chiapas. Cult. Survival Quart. 10:45.

Beavers, J.B., and Calkins, C.O., 1984. Susceptibility of *Anastrepha suspensa* (Diptera: Tephritidae) to steinernematid and heterorhabditid nematodes in laboratory studies. Environ. Entomol. 13: 137-139.

Bender, M.E., 1969. Uptake and retention of malathion by the carp. Prog. Fish Cult. 31(3):155.

Brewer, B.S., and Tippins, H.H., 1982. Chemical control of *Saissetia coffeae* on Boston fern. J. Georgia Entomol. Soc. 17(1):32-38.

Brezonik, P.L., and Fox, J.L, 1974. The limnology of selected Guatemalan lakes. Hydrobiologia 45(4):467-487.

Brown, L., and Amadon, D., 1968. Eagles, hawks and Falcons of the World. McGraw-Hill Book Company, New York, NY.

Burditt, A.K., Jr., and Seo, S.T., 1971. Dose requirements for quarantine treatment of fruit flies with gamma irradiation. *In:* Disinfection of fruit by irradiation, p. 33. Joint FAO/IAEA of Atomic Energy in Food and Agriculture, Vienna.

Calabrese, E.J., 1978. Pollutants and high-risk groups. The biological basis of increased human susceptibility to environmental and occupational pollutants. John Wiley and Sons, New York, NY.

California Department of Food and Agriculture, Environmental Hazards Assessment Program, 1990. Technical summary environmental monitoring results for the Mediterranean fruit fly malathion aerial treatment program results for the applications of February 12-23, 1990.

Campbell, J.R., and Penner, D., 1979. Incompatibility of bentazone and organophosphate insecticide combinations. Proc. N. Central Weed Control Conf. 34:12.

Carey, J.R., 1984. Host-specific demographic studies of the Mediterranean fruit fly *Ceratitis capitata*. Ecol. Entomol. 9:261-270.

Caron, D.M., 1979. Effects of some ULV mosquito abatement insecticides on honeybees. J. Econ. Entomol. 72:148.

Chambers, D.L., 1990. Comments on Document by Prof. Carey of March 26, 1990, and Published Commentary, UC Davis Magazine, May/June 1990, p. 5. U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Guatemala Medfly Methods Station.

Chapman, R.A., and Cole, C.M., 1982. Observations on the influence of water and soil pH on the persistence of insecticides. J. Environ. Sci. Health 17: 487.

Cheikh, M., Howell, J.F., Harris, E.J., Salah, H., and Soria, F., 1975. Suppression of the Mediterranean fruit fly in Tunisia with released sterile insects. J.Econ. Entomol. 68:237-243.

Chiou, C.T., Freed, V.H., Schmedding, D.W., and Kohnert, R.L., 1977. Partition coefficient and bioaccumulation of selected organic chemicals. Envir. Sci. Technol. 11(5):475.

Chong, M., 1962. Production methods for fruit fly parasites. Proc. Hawaiian Ent. Soc. 18:61.

Choo, H.Y., Kaya, H.K., Burlando, T.M., and Gaugler, R., 1989. Entomopathogenic nematodes: Host-finding ability in the presence of plant roots. Environ. Entomol. 18:1136-1140.

Christenson, L.D., and Foote, R.H., 1960. Biology of fruit flies. Ann. Rev. Entomol. 5:171.

Coelho, A.M., Jr., Coelho, L.S., Bramblett, C.A., Bramblett, S.S., and Quick, L.B., 1976. Ecology, population characteristics, and sympatric association in primates: A socio-bioenergetic analysis of howler and spider monkeys in Tikal, Guatemala. Yearbook Phys. Anthro. 20:96.9

Collar, N.J., and Andrew, P., 1988. Birds to watch. The ICBP world checklist of threatened birds. Smithsonian Institution Press, Washington, DC.

Comision MOSCAMED, undated. Comision MOSCAMED Document MM. No. 47.

Conant, R., 1975. A field guide to reptiles and amphibians of Eastern and Central North America. Houghton Mifflin Company, Boston.

Consortium for International Crop Protection (CICP), 1988. Guatemala Medfly Environmental Impact Analysis. Submitted to the U.S. Agency for International Development, Bureau for Latin America and the Caribbean, and U.S.A.I.D. Mission to Guatemala. Consortium for International Crop Protection, College Park, MD.

Cook, J.W., 1955. Paper chromatography of some organic phosphate insecticides. V. Conversion of organic phosphates to *in vitro* cholinesterase inhibitors by N-bromosuccinimide and ultraviolet light. J. Assoc. Offic. Agric. Chemists 38:826.

Council on Environmental Quality, 1972. Integrated pest management. Council on Environmental Quality.

Cunningham, R.T., Routhier, W., Harris, E.J., Cunningham, G., Johnson, L., Edwards, W., Rosander, R., and Vettel, W.G., 1980. Eradication of Medfly by sterile male release. Citrograph 65:63.

Cunningham, R.T., Steiner, L. F., Ohinata, K., and Farias, G.J. 1970. Mortality of male melon flies and male Mediterranean fruit flies treated with aerial sprays of lure and naled formulated with a monoglyceride or siliceous extender. J. Econ. Entomol. 63(1):106-110.

Curley, W.H., and Donohue, J.M., 1986. Risk analysis of multiple pesticide applications for the rangeland management program. V.J. Ciccone and Associates, Inc., VA.

Daughton, C.G., and Hsieh, D.P.H., 1977. Accelerated parathion degradation in soil by inoculation with parathion utilizing bacteria. Bull. Environ. Cont. Tox. 18:48.

Davis, L.I., 1972. A field guide to the birds of Mexico and Central America. The William Byrd Press, Richmond, VA .

Degraeve, N., Chollet, M.C., Moutschen, J., 1984. Cytogenetic and genetic effects of subchronic treatments with organophosphorus insecticides. Arch. Toxicol. 56(1):66-67.

Delgado, H.L., 1987. Situacion alimentaria nutricional de Centroamerica y Panama. INCAP Publ. E-1222. Guatemala.

Dennis, D.J., 1978. Observations of fungus gnat damage to glasshouse cucurbits. N.Z. J. Exper. Agric. 6(1):83-84.

Dobroski, C.J., Jr., and Lambert, W.P., 1984. Malathion: a profile of its behavior in the environment. U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine. Contract no. 53-6395-1-151.

DOT – See U.S. Department of Transportation.

Drouin, J.A., and Kusch, D.S., 1979. Chemical control trials on the box elder twig borer in Alberta. Bi-monthly Res. Notes 35(4):23.

ECOTECNIA Consultores Asociados, 1985. Evaluacion economica del impacto de la mosca del mediterraneo (*Ceratitis capitata* Wied.) en Guatemala.

Edwards, C.A., 1969. Soil pollutants and soil animals. Sci. Amer. 220:88.

Edwards, C.A., Dennis, E.B., and Empson, D.W., 1967. Pesticides and the soil fauna: Effects of aldrin and DDT in an arable field. Ann. Appl. Biol. 60:11.

Edwards, C.A., Thompson, A.R., 1973. Pesticides and the soil fauna. Residue Rev. 45:1.

Edwards, C.A., Thompson, A.R., and Beynon, K.I., 1968. Some effects of chlorfenvinphos, an organophosphorus insecticide, on populations of soil animals. Rev. Ecol. Biol. Sol. 5:199.

Edwards, C.A., Thompson, A.R., and Lofty, J.R., 1967. Changes in soil invertebrate populations caused by some organophosphate insecticides. Proc. Brit. Insectic. Fungic. Conf. 4th 1:48.

Ehler, L.E., and Endicott, P.C., 1984. Effect of malathion-bait sprays on biological control of insect pests of olive, citrus, and walnut. Hilgardia 52(5):1-47.

Ehrlich, P.R., Dobkin, D.S., and Wheye, D., 1988. The birder's handbook: A field guide to the natural history of North American birds. Simon and Schuster, New York, NY.

Eichelberger, J.W., and Lichtenberg, J.J., 1971. Persistence of pesticides in river water. Environ. Sci. Technol. 5(6):541.

El-Gazzar, L.M., 1979. Induced sterility in the Mediterranean fruit fly using heat treatments. Z. Ang. Ent. 88:436.

El-Rafai, A., and Hopkins, T.L., 1965. Thin layer chromatography and cholinesterase detection of several phosphorothiono insecticides and their oxygen analogs. J. Agric. Food Chem. 13:477.

ENVIRON Corporation, 1988. Elements of toxicology and chemical risk assessment. ENVIRON Corporation, Washington, DC.

EPA—See U.S. Environmental Protection Agency.

Eskafi, F.M., 1988. Infestation of citrus by *Anastrepha* spp. and *Ceratitis capitata* (Diptera: Tephritidae) in high coastal plains of Guatemala. Environ. Entomol. 17:52.

Eskafi, F.M., and Kolbe, M.M., 1990. Predation on larval and pupal Ceratitis capitata (Diptera: Tephritidae) by the *Solenopsis geminata* (Hymenoptera: Formicidae) and other predators in Guatemala. Environ. Entomol. 19: 148-153.

Finney, G.L., 1953. A summary report in the mass culture of fruit flies and their parasites in Hawaii. *In*: Third special report on the control of the oriental fruit fly (*Dacus dorsalis*) in the Hawaiian Islands. Joint Legislative Committee on Agriculture and Livestock Problems. Senate of the State of California.

Foerster, J., 1972. Notas biologicas sobre *Harpia harpyia* (Linne). Neotropica 18:146-148.

Forshaw, J.M., 1973. Parrots of the world. Doubleday and Company, Inc., Garden City, NY.

Georgis, R., and Poinar, G.O., Jr., 1983. Vertidal migration of *Heterorhabitis bacteriophora* and *H. heliothidis* (Nematoda: Heterorhabditidae) in sandy loam soil. J. Nematol. 15: 652-654.

Gibson, W.P., and Burns, R.G., 1977. The breakdown of malathion in soil and soil components. Microbiol. Ecol. 3(3):219.

Giles, H.R., Jr., 1970. The ecology of a small forested watershed treated with the insecticide malathion-S^{35}. Wild. Monogr. No. 24.

Ginrich, R.E., 1987. Demonstration of *Bacillus thuringiensis* as a potential control agent for the adult Mediterranean fruit fly, *Ceratitis capitata* (Weid.). J. Appl. Entomol. 104(4):378-385.

Gonzalez, T., 1981. Tecnicas de reproduccion de *Ceratitis capitata* Wied. y algunos parasitos de las moscas de la fruta. OIRSA Technical Bulletin SV No. 1.

Greany, P.D., Styer, S.L., Davis, P.L., Shaw, P.E., and Chambers, D.L., 1983. Biochemical resistance of citrus to fruit flies—demonstration and elucidation of resistance to the Caribbean fruit fly *Anastrepha suspensa*. Ent. Exp. Appl. 34:40.

Grether, J.K., Harris, J.A., Neutra, R., and Kizer, K.W., 1987. Exposure to aerial malathion application and the occurrence of congenital anomalies and low birth weight. Am. J. Public Health 77(8):1009-1010.

Griffiths, D.C., and Walker, N., 1970. Microbial degradation of parathion. Rijksfac. Landbouwet. Ghent. Meded. 35:805.

Gunther, F.A., and Gunther, J.D., 1981. Residue Reviews: Residues of pesticides and other contaminants in the total environment. Springer-Verlag, New York, NY.

Hagen, K.S., 1953. Influence of adult nutrition upon the reproduction of three fruit fly species. *In*: Third special report on the control of the oriental fruit fly (*Dacus dorsalis*) in the Hawaiian Islands. Senate of the State of California.

Hagen, K.S., Sawall, E.F., Jr., and Tassan, R.L., 1970. The use of food sprays to increase effectiveness of entomophagous insects. Proc. Tall Timbers Conf. Animal Contr. Habitat Mgmt. 1:59-81.

Hall, R.J., and Kolbe, E., 1980. Bioconcentration of organophosphorus pesticides to hazardous levels by amphibians. J. Tox. and Environ. Health 6(4) :853-860.

Harris, E.J., and Okamoto, R.Y., 1983. Description and evaluation of a simple method for the collection of the parasite *Biosteres oophilus*. Entomophaga 28:241.

Hartley, D., and Kidd, H., 1987. The Agrochemicals Handbook. Royal Society of Chemistry. Nottingham, England.

Hendrichs, J., and Hendrichs, M.A., 1990. Mediterranean fruit fly (Diptera: Tephritidae) in nature: Location and diel pattern of feeding and other activities on fruiting and nonfruiting hosts and nonhosts. Ann. Entomol. Soc. Am. 83(3):632-641.

Hill, A.R., 1986. Choice of insecticides in Steiner traps affects the capture rate of fruit flies (Diptera: Tephritidae). J. Econ. Entomol. 79:533-536.

Hitchcock, B.E., 1965. Field and laboratory studies of DDT and aquatic insects. Conn. Agr. Exp. Sta. Bull. 668.

Honeycutt, R.C., Guther, Z., and Ragsdale, N.N., 1985. Dermal exposure related to pesticide use. ACS Symposium Series 273. American Chemical Society, Washington, DC.

Houk, V.S., and DeMarini, D.M., 1987. Induction of prophage Lambda by chlorinated pesticides. Mutation Res. 182(4):193-201.

Hudson, R.H., Tucker, R.K., and Haegele, M.A., 1984. Handbook of toxicity of pesticides to wildlife. Resource Publication 153. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Huff, J.E., Bates, R., Eustis, S.L., Haseman, J.K., and McConnell, E.E., 1985. Malathion and malaoxon: Histopathology reexamination of the National Cancer Institute's carcinogenesis studies. Environ. Res. 37(1):154-173.

Hyche, L.L., 1956. Control of mites infesting earthworm beds. J. Econ. Entomol. 49:409.

Ichinohe, F., Hashimoto, T., and Nakasone, S., 1977. Faunal survey of insects and spiders killed by protein hydrolysate insecticide bait for control of melon fly. Res. Bull. Pl. Prot. Japan No. 14:64-70.

Instituto Interamericano de Cooperacion para la Agricultura, undated. IICA Paper 0009/591.5 EC 17.

Ishitani, A., Yukimoto, M, and Yoshida, K., 1975. Phytotoxicities of agricultural chemicals to crops. II. Organophosphorus insecticides. Bull. Agric. Chem. Inspec. Sta. 1975, 15:92-97.

Izor, R.J., 1985. Sloths and other mammalian prey of the harpy eagle. *In:* The evolution and ecology of armadillos, sloths, and vermilinguas. G.C. Montgomery (ed.). Smithsonian Institution Press, Washington, DC.

Janzen, D.H., 1971. Euglossine bees as long-distance pollinators of tropical plants. Science. 171: 203-205.

Janzen, D.H., 1983. Costa Rican natural history. University of Chicago Press, Chicago, IL.

Johnsgard, P.A., 1988. The quails partridges, and francolins of the world. Oxford University Press, Oxford, England.

Keiser, I., 1968. Residual effectiveness of foliar sprays against the Oriental fruit fly, melon fly, and Mediterranean fruit fly. J. Econ. Entomol. 61(2):438-443.

Keiser, I., Kobayashi, R.M., Schneider, E.L., and Tomikawa, I., 1973. Laboratory assessment of 73 insecticides against the Oriental fruit fly, melon fly, and Mediterranean fruit fly. J. Econ. Entomol. 66(4):837-839.

Keiser, I., Steiner, L.F., and Kamasaki, H., 1965. Effect of chemosterilants against the oriental fruit fly, melon fly and Mediterranean fruit fly. J. Econ. Entomol. 58:682.

Keiser, I., and Tomikawa, I., 1970. Species-specific toxicity of certain insecticides to tephritids in Hawaii suggested by unusual susceptibility relationships among Oriental fruit flies, melon flies, and Mediterranean fruit flies. J. Econ. Entomol. 63(4):1746-1748.

Keplinger, M.L., and Deichmann, W.B., 1967. Acute toxicity of combinations of pesticides. Toxicol. Applied Pharmacol. 10:586-595.

Khan, R.R., and Dev, B., 1982. Toxicity data sheets on chemicals: Malathion. Govt. Reports Announcements (GRA&I), Index issue 20.

King, W.B., 1981. Endangered birds of the world. The ICBP bird red data book. Smithsonian Institution Press, Washington, DC.

Kirby, M., and Santelmann, P.W., 1973. Compatibility of tank mixtures of herbicides and insecticides. Proc. 26th Ann. Meeting Southern Weed Sci. Soc.

Knipling, E.F., 1979. The basic principles of insect population suppression and management, 659 p. USDA, Science and Education Admin. USDA Agr. Handbook 512, Washington, DC.

Lack, D., 1968. Ecological adaptations for breeding in birds. Methuen and Company, Ltd., London.

Land, H.C., 1970. Birds of Guatemala. Livingston Publishing Company, Wynnewood, PA.

Lavy, T.L., et al., 1982. (2,4-Dichlorophenoxy)acetic acid exposure received by aerial application crews during forest spray operations. J. Agric. Food Chem. 30:375.

Lavy, T.L., et al., 1987. Exposure of forestry ground workers to 2,4-D, picloram and dichlorprop. Environ. Toxol. Chem. 6:209.

Lavy, T.L., Shepard, J.S., and Mattice, J.D., 1980. Exposure measurements of applicators spraying (2,4,5 trichlorophenoxy) acetic acid in the forest. J. Agric. Food Chem. 28:626.

Leonard, H.J., 1987. Natural resources and economic development in Central America. Int. Inst. Envir. Develop., Washington, DC.

Leonhardt, B.A., Cunningham, R.T., Rice, R.E., Harte, E.M., and Hendrichs, J., 1989. Design, effectiveness, and performance criteria of dispenser formulations of Trimedlure, an attractant of the Mediterranean fruit fly (Diptera: Tephritidae). J. Econ. Entomol. 82(3):860-867.

Le Pelly, R. H., 1968. Pests of coffee, 590 p. Longmans, Green, and Co., Ltd., London.

Lindegren, J.E., Wong, T.T., and McInnis, D.O., 1990. Response of Mediterranean fruit fly (Diptera: Tephritidae) to the entomogenous nematode *Steinernema feltiae* in field tests in Hawaii. Environ. Entomol. 19: 383-386.

Lindegren, J.E., and P.V. Vail, 1986. Susceptibility of Mediterranean fruit fly, melon fly and oriental fruit fly (Diptera: Tephritidae) to the entomogenous nematode *Steinernema feltiae* in laboratory tests. Environ. Entomol. 15: 465-468.

Marx, J.L., 1981. Malathion threat debunked. Sci. 213(4507):526-527.

Matsumura, F., 1975. Toxicity of insecticides. Plenum Press, New York, NY.

Matsumura, F., and Boush, G.M., 1966. Malathion degradation by *Trichoderma viride* and a *Pseudomonas* species. Sci. 153:1278.

Mitchell, W.C. (Team Leader), 1977. The Mediterranean fruit fly and its economic impact on Central American countries and Panama. UC/A.I.D. Pest Management and Related Environmental Protection Project, Univ. Calif., Berkeley. *In:* Consortium for International Crop Protection, 1988. Guatemala Medfly Environmental Impact Analysis.

Morales, E., 1984. Resena historica y desarrollo actual de control biologico de plagas agricolas en Costa Rica, 20 p. International Roundtable on Biological Control. Officina Regional de la FAO America Latina y El Caribe, OILB. EXAS.

Mote, U.N., 1976. Phytotoxicity of modern insecticides to cucurbits. J. Maharashtra Agric. Univ. 1(1):39-42.

Moy, J.H., Kaneshiro, K.Y., Ohta, A.T., and Nagai, N., 1983. Radiation disinfestation of California stone fruits infested by Medfly—effectiveness and fruit quality. J. Food Sci. 48: 931-934.

Mracek, Z., and Spitzer, K., 1983. Interaction of the predators and parasitoids of the sawfly *Cephalcia abietis* (Pamphilidae: Hymenoptera) with its nematode *Steinernema kraussei*. J. Invert. Path. 42: 397-399.

Mulla, M.S., Mian, L.S., and Kawecki, J.A., 1981. Distribution, transport, and fate of insecticides. Residue Rev. 81. Springer-Verlag, New York, NY.

Munnecke, D.M., and Hsieh, D.P.H., 1976. Pathways of microbial metabolism of parathion. Appl. Envir. Microbiol. 31:63.

Musau, D.M., and Parry, W.H., 1988. Comparison of the potential of organophosphorus insecticides and soaps in conifer aphid control. Crop Prot. 7(4):267-272.

Nakagawa, S., Chambers, D.L., Bradshaw, T.I., Urago, T., and Harris, E.J., 1975. Performance of a sticky trap with Trimedlure impregnated in the adhesive material. J. Econ. Entomol. 68(6):817-818.

Nakagawa, S., Chambers, D.L., Urago, T., and Cunningham, R.T., 1971. Trap-lure combinations for surveys of Mediterranean fruit flies in Hawaii. J. Econ. Entomol. 64(5):1211-1216.

National Cancer Institute (NCI), 1978. Bioassay of malathion for possible carcinogenicity. DHEW Publication No. (NIH) 78-824.

National Institute for Occupational Safety and Health (NIOSH), 1987. Registry of the effects of chemical substances, Washington, DC.

National Research Council, 1983. Risk assessment in the federal government: Managing the process. 191 pp. Natiional Academy Press, Washington, DC.

Ohinata, I., Ashraf, M., and Harris, E.J., 1977. Mediterranean fruit flies; sterility and sexual competitiveness in the laboratory after treatment with gamma irradiation in air, carbon dioxide, helium, nitrogen or partial vacuum. J. Econ. Entomol. 70:165.

Ohinata, K., Fujimoto, M., Higa, H., Tanaka, N., and Harris, E.J., 1978. Mediterranean fruit fly: gamma irradiation in nitrogen and packaging for sterile insect release program in Los Angeles. J. Econ. Entomol. 71: 610.

Olivier, P.G., and Ryke, P.A.J., 1969. The influence of citricultural practices on the composition of soil Acari and Collembollan populations. Pedobiol. 9:277.

Pascal, D.C., and Neville, M.E., 1976. Chemical and microbial degradation of malaoxon in an Illinois soil. J. Environ. Qual. 5(4):441.

Pasol, P., Nadejde, M., and Schmidt, E., 1978. Experiments on the control of the oat aphid *Macrosiphum* (Sitobion) *avenae* F. with ultra-low-volume insecticide formulations. Lucrari Stiintifice, Institutul Agronomic 'Nicolai Balcescu', A 1975/1976, 18/19:49-58.

Pasquier, R.F., 1981. Conservation of new world parrots. Smithsonian Institution Press, Washington, DC.

Payne, J.A., Gentry, C.R., and Sparks, D., 1977. Pecan bud moth: control with soil-applied systemics and foliar sprays. J. Georgia Entomol. Soc. 12(3):236-241.

Peterson, R.T., 1980. A field guide to the birds east of the Rockies. Houghton Mifflin Company, Boston, MA.

Peterson, R.T., and Chalif, E.L., 1973. Mexican birds, 298 p. Houghton Mifflin Company, Boston, MA.

Plus, N., and Cavalloro, R., 1983. The viruses of *Ceratitis capitata* Wied. *in* vivo and *in vitro*, p. 106-112. *In* : R. Cavalloro (ed.) Fruit flies of economic importance. Proc. CEC/IOBC Int. Symp. Athens, Greece. A.A. Balkema, Rotterdam, The Netherlands.

Poinar, G.O., Jr., 1983. The Natural History of Nematodes, p. 170. Prentice-Hall, Inc., Englewood Cliffs, NJ.

Rafael Landivar University, 1984. Environmental profile of Guatemala—executive summary. Institute of Environmental Sciences and Agricultural Technology. URL/AID-Guatemala/ROCAP Contract No. 596-0000-C-00-3060-00.

Reinert, J.A., and Neel, P.L., 1977. Evaluation of phytotoxicity of malathion, ethion, and combinations of FC-435 spray oil with each on twenty-eight species of environmental plants under slat shade. Proc. Florida State Hort. Soc. 1976, 89:368-370.

Reuber, M.D., 1985. Carcinogenicity and toxicity of malathion and malaoxon. Environ. Res. 37(1):119-153.

Rowlands, D.G., 1965. The *in vitro* and *in vivo* oxidation and hydrolysis of malathion by grain esterases. J. Sci. Food Agric. 16:325.

Saul, S.H., Tsuda, D., and Wong, T.T.Y., 1983. Laboratory and field trials of soil applications of methoprene and other insecticides for control of the Mediterranean fruit fly (Diptera: Tephritidae). J. Econ. Entomol. 76:174-177.

Schalk, J.M., 1990. To obtain efficacy data of insecticides on vegetable crops against insects. U.S. Department of Agriculture, Agricultural Research Service.

Seo, S.T., Kobayashi, R.M., Chambers, D.L., Dollar, A.M., and Hanacka, M., 1973. Hawaiian fruit flies in papayas, bell pepper and eggplant; quarantine treatment with gamma irradiation. J. Econ. Entomol. 66: 937.

Shacter, B., 1981. Treatment of scabies and pediculosis with lindane preparations: An evaluation. J. Am. Acad. Dermatol. 5(5):517-527.

Short, L.L., 1982. Woodpeckers of the world. Delaware Museum of Natural History, Greenville, DE.

Skutch, A.F., 1983. Birds of tropical America. Univeristy of Texas Press, Austin, TX.

Smithe, F.B., 1966. The birds of Tikal. The Natural History Press, Garden City, NY.

Standley, P.C., and Steyermark, J.A., 1946. Flora of Guatemala Fieldiana: Botany 24(4):266-268.

Steffens, R.J., 1982. The combi-fly, a new concept for genetic control of fruit flies. Naturwissenschaften 69:600.

Steffens, R.J., 1983. Combination of radiation- and translocation-induced sterility for genetic control of fruit flies. Entomol. Exp. Appl. 33:253.

Steiner, L.F., 1952. Fruit fly control in Hawaii with poison- bait sprays containing protein hydrolysates. J. Econ. Entomol. 45(5):838-843.

Steiner, L.F., 1955. Fruit fly control with bait sprays in relation to passion fruit production. Proc. Hawaiian Entomol. Soc. 15(3):601-607.

Steiner, L.F., Mitchell, W.C., and Ohinata, K., 1958. Fruit fly control with poisoned-bait sprays in Hawaii. ARS Publication #33-3. U.S. Department of Agriculture, Agricultural Research Service.

Steiner, L.F., Rohwer, G.G., Ayers, E.L., and Christenson, L.D., 1961. The role of attractants in the recent Mediteranean fruit fly eradication program in Florida. J. Econ. Entomol. 54:30-35.

Steiner, L.F., Mitchell, W.C., and Baumhover, A.H., 1962. Progress of fruit fly control by irradiation sterilization in Hawaii and the Marianas Islands. Int. J. Appl. Rad. and Isot. 13:427.

Stephenson, G.R., Phatak, S.C., Makowski, R.I., and Bouw, W.J., 1980. Phytotoxic interactions involving metribuzin and other pesticides in tomatoes. Can. J. Pl. Sci. 60(1):167-175.

Steyn, J.J., 1955. The effect of mixed ant populations on the red scale *(Aonidiella aurantii)* at Letebs. J. Ent. Soc. S. Afr.18: 93-105. (Original not seen, cited in Ongute, G.M., 1970.) The Mediterranean fruit fly *Ceratitis capitata.* Kenya Coffee 36: 257.

Takara, J.M., Beardsley, J.W., Harris, E.J., and Vargas, R.I., 1983. Final report on a survey of fruit fly and endemic insect distribution on Kauai, Hawaiian Islands. Report to USDA-ARS, Honolulu. Unpublished. University of Hawaii, Manoa.

Tanner, J.T., 1964. The decline and present status of the imperial woodpecker of Mexico. Auk 81:74-81.

Terres, J.K., 1980. The Audubon Society encyclopedia of North American birds, 1109 p. Alfred A. Knopf, Inc., New York, NY.

Thien, L.B., 1974. Floral biology of *Magnolia*. Amer. J. Bot. 61:1037-1045.

Thompson, A.R., and Edwards, C.A., 1974. Effects of pesticides on nontarget invertebrates in freshwater and soil. In: Pesticides in soil and water. Guenzi, W. D., ed. Soil Science Society of America, Inc.

Timper, P., Kaya, H.K., and Gaugler, R., 1988. Dispersal of the entomogenous nematode *Steinernema feltina* (Rhabditida: Steinernematidae) by infected adult insects. Environ. Entomol. 17(3): 546-550.

Tinscher, O., [Commercial orchid producer]. Personal communication in CICP, 1988.

Toia, R.F., March, R.B., Umetsu, N., Mallipudi, N.M., Allahyari, R., and Fukuto, T.R., 1980. Identification and toxicological evaluation of impurities in technical malathion and fenthion. J. Agric. Food Chem. 28(3):599.

Troetschler, R., 1983. Effects on nontarget arthropods of malathion bait sprays used in California to eradicate the Mediterranean fruit fly, *Ceratitis capitata* (Wiedmann) (Dystera: Tephritidae). Environ. Entomol. 12:1816-1822.

Turner, J.W., Baily, P., and Swincer, D., 1984. Disinfection of imported flowers and plants, p. 488-493. Proc. 4th Australian Appl. Entomol. Res. Conf. Pest control: Recent adv. future prospects. Baily, P., and Swincer, D. (eds.).

U.S. Agency for International Development, 1988. Guatemala Medfly environmental impact analysis. USAID Contract No. DAN-4142-C-00-5122-00-Modification No. 7.

USAID—See U.S. Agency for International Development

USDA—See U.S. Department of Agriculture

U.S. Department of Agriculture, APHIS, PPD, 1989. Economic analysis of the Guatemala MOSCAMED, Hyattsville, MD.

U.S. Department of Agriculture, APHIS, PPQ, 1987. Draft environmental assessment—MOSCAMED—Mediterranean fruit fly eradication program. Hyattsville, MD.

U.S. Department of Agriculture, APHIS, 1985. Eradication of the trifly complex from the State of Hawaii, environmental impact statement, final draft, USDA-APHIS. Hyattsville, MD.

U.S. Department of the Interior, Fish and Wildlife Service, 1979. Eastern brown pelican recovery plan. U.S. Fish and Wildlife Service, Washington, DC.

U.S. Department of the Interior, Fish and Wildlife Service, 1982. Pacific Coast American peregrine falcon recovery plan. U.S. Fish and Wildlife Service, Portland, OR.

U.S. Department of the Interior, Fish and Wildlife Service, 1983. California brown pelican recovery plan. U.S. Fish and Wildlife Service, Portland, OR.

U.S. Department of the Interior, Fish and Wildlife Service , 1984a. American peregrine falcon recovery plan (Rocky Mountain/Southwest population). U.S. Fish and Wildlife Service, Denver, CO.

U.S. Department of the Interior, Fish and Wildlife Service, 1984b. Recovery plan for marine turtles. U.S. Fish and Wildlife Service, Atlanta, GA.

U.S. Department of the Interior, Fish and Wildlife Service, 1986. Recovery plan for the U.S. breeding population of the wood stork. U.S. Fish and Wildlife Service, Atlanta, GA.

U.S. Department of the Interior, Fish and Wildlife Service, 1987. Revised peregrine falcon (eastern population) recovery plan. U.S. Fish and Wildlife Service, Newton Corner, MA.

U.S. Department of Transportation, 1980. Principles of toxicological interactions associated with multiple chemical exposures. U.S. Coast Guard, Office of Merchant Marine Safety, Washington, DC.

U.S. Environmental Protection Agency, 1984. Approaches to risk assessment for multiple chemical exposures. Environmental Criteria and Assessment Office, Office of Research and Development, Cincinnati, OH.

U.S. Environmental Protection Agency, 1986a. Superfund public health evaluation manual. Office of Emergency and Remedial Response. EPA/540/1-86/060, Washington, DC.

U.S. Environmental Protection Agency, 1986b. Standard evaluation procedures: ecological risk assessment. Hazard Evaluation Division. Washington, DC.

U.S. Environmental Protection Agency, 1988a. Tox one-liner: Malathion February 22, 1988. Office of Pesticides and Toxic Substances. Washington, DC.

U.S. Environmental Protection Agency, 1988b. Guidance for the reregistration of pesticide products containing malathion as the active ingredient. Office of Pesticides and Toxic Substances, Washington, DC.

Walker, W.W. and Stojanovic, B.J., 1973. Microbial versus chemical degradation of malathion in soil. J. Environ. Qual. 2(2):229.

Washburn, J.A., Tassan, R.L., Grace, K., Bellis, E., Hagen, K.S., and Frankie, G.W., 1983. Effects of malathion sprays on the ice plant insect system. Calif. Agric. Jan.-Feb.:30-32.

Weber, G., 1953. Die makrofauna leichter und schwerer Ackerboden und ihre Beeinflussung durch Pflanzenschutzmittle. Pflanzenernahr Dung. 61:107.

Wetmore, A., 1972. The birds of the republic of Panama. Smithsonian Institution Press, Washington, DC.

Whitman, P.L., 1988. Biology and conservation of the endangered interior least tern: a literature review. U.S. Fish and Wildlife Service, Washington, DC.

Wolfe, J.L., Bradshaw, D.K., and Chabreck, R.H., 1987. Alligator feeding habits: New data and a review. NE Gulf Sci. 9(1):1.

Wolfe, N.L., Zepp, R.G., Gordon, J.A., Baughman, G.L., and Cline, D.M., 1977. Kinetics of chemical degradation of malathion in water. Environ. Sci. Technol. 11(1):88-93.

Wong, T.T.Y., Mochizuki, N., and Nishimoto, J.I., 1984a. Seasonal abundance of parasitoids of the Mediterranean and oriental fruit flies (Diptera: Tephritidae) in the Kula Larea of Maui, Hawaii. Envir. Ent. 13:140.

Wong, T.T.Y., McInnis, D.D., Nishimoto, J.I., Ota, A.K., and Chang, V.C.S., 1984b. Predation of the Mediterranean fruit fly (Diptera: Tephritidae) by the Argentine Ant (Hymenoptera: Formicidae) in Hawaii. J. Econ. Ent. 77:1454.

Wood, M., 1989. New lure attracts Medfly males. Agricultural Research, February 1989, p. 19.

World Wildlife Fund - Conservation Foundation, 1990. The official World Wildlife Fund guide to endangered species of North America. Vol. 1 Plants, mammals. Beachman Publishing, Inc., Washington, DC.

Zepp, R.G., and Cline, D.M., 1977. Rates of direct photolysis in aquatic environment. Envir. Sci. Technol. 11(4):359.

Appendix 2. Glossary

Acceptable Daily Intake	The level of pesticide residue that may be consumed each day throughout the course of an average human life span without appreciable risk.
Acetylcholine	A chemical involved in the transmission of nerve impulses across junctions in the nervous system.
Acetylcholinesterase	An enzyme essential to the proper functioning of animal nervous systems; cholinesterase.
Acute	Immediate or short-term; generally within 24 hours.
ADI	See Acceptable Daily Intake.
Aerial Release	Release of sterile Medflies from aircraft flown through the Medfly target area.
Agroecosystem	The agricultural environment, including interrelated biological and physical components.
a.i.	Active ingredient.
Aldrin	An organochlorine insecticide, not used in the Guatemala MOSCAMED Program.
Anastrepha	A genus of tephritid fruit fly (related to the Medfly) which attacks many of the same plant hosts.
Annelids	A major taxonomic grouping of worms comprising earthworms, leeches, various marine worms, etc., characterized by ringed or segmented bodies.
APHIS	Animal and Plant Health Inspection Service (an agency within USDA).
Aquaculture	The culture and/or harvesting of aquatic organisms such as fish or shrimp for commercial purposes.
Arthropoda	A major taxonomic grouping of animals characterized by jointed limbs and a segmented, shell-like external covering; includes insects, crustaceans, spiders, and mites.
Attractant	A substance that lures (attracts) an organism.

Bagasse — The dry pulp remaining from sugar cane or sugar beets after the juice has been extracted; used as a bulking agent in diet medium for Medfly production.

Barrier — A set of actions to prevent the movements of organisms beyond a given location.

Bioaccumulation — Process by which the concentration of a pesticide (or other chemical) is increased in organisms due to their inability to degrade or metabolize it; in time the concentration of the chemical is higher in the organism than in the organism's environment.

Biodiversity — The relative abundance and frequency of biological organisms within ecosystems.

Biological Control — The use of living organisms to reduce pest populations; use of predators, parasitoids, and pathogens against pests.

Boric Acid — An inorganic compound used as a fungicide, a herbicide, and an insecticide; also known as boracic acid or orthoboric acid.

Buffer Zone — Refers to two different types: an area where control treatments are foregone or are modified to protect an adjacent environmentally sensitive area; or an area where control treatments are employed to enhance eradication efforts in an adjacent area.

Carcinogen — A substance that causes cancer.

CEQ — Council on Environmental Quality (U.S.).

Ceratitis capitata — Mediterranean fruit fly; Medfly.

CFR — Code of Federal Regulations (U.S.).

Cholinergic Poisoning — Poisoning accompanying inhibition of the enzyme acetylcholinesterase (= cholinesterase).

Cholinesterase — See Acetylcholinesterase.

Cholinesterase Inhibitor — A chemical that inhibits or damages the enzyme acetylcholinesterase essential for proper nerve function.

Chronic — Of long duration; generally longer than 24 hours.

CICP — Consortium for International Crop Protection, College Park, Maryland.

CIRSA — Consortio Internacional Regional de Sanidad Agropecuaria; executive body that directs OIRSA activities; made up of Minister of Agriculture of the Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, and Panama. (See OIRSA)

CNS — Central nervous system.

Collembola — The order of insects which contains the springtails.

Competitive Displacement — One species replacing another in a particular ecological niche through superior competition for resources.

Conveyances — Vehicles at quarantine stations (literally, carriers).

CORECA — Comite Geional de Cooperacion en Agricultura; a regional agricultural organization.

Critical Habitat — Habitat that has been designated as critical to the survival of endangered or threatened species, and listed in 50 CFR 17 or 226.

Crop Diversification — Increasing the variety of crops currently cultivated.

Cultural Controls — Crop management and other practices that make the environment less favorable for pests—e.g., field sanitation, crop rotation, special harvesting practices, time of planting, trap crops.

DDT — An organochlorine insecticide, generally not used because of environmental concerns.

DDVP — See dichlorvos.

Degree Day — A day for which the temperature exceeds a calculated threshold temperature; used to predict developmental times of Medflies.

Dermal LD_{50} — Bioassay based statistical estimate of the dosage (in milligrams of chemical per kilogram of body weight of the exposed animal) for skin exposure that would be lethal to 50% of the experimental population of the test species.

Dichlorvos — 2,2-dichlorovinyl dimethyl phosphate; an insecticide; DDVP.

DNA — Deoxyribonucleic acid; functions in the transfer of genetic information.

DOT — United States Department of Transportation.

Dye Cards — Small paper cards coated with a dye to detect spray droplets; used to evaluate aerial bait spray applications for droplet size, distribution, or other properties.

EA — Environmental Assessment.

EC — See Emulsifiable Concentrate; a formulation of pesticide in a water emulsion (the pesticide and water do not dissolve, but are mixed).

EC_{50} — Median effective concentration; the concentration of toxicant in the environment that produces a designated effect on 50 percent of the exposed test organisms.

Economic Threshold — The point at which pest density or level of crop damage economically justifies pest control; the point where profits from increased yield under control exceed cost of control.

Ecosystem — An ecological community together with its physical environment.

EEC — See Estimated Environmental Concentration.

Effective Environmental Concentration — The amount of pesticide residue that will be in the environment and have a toxic effect on an organism.

EIA — Environmental Impact Analysis.

EIS — Environmental Impact Statement.

Emulsifiable Concentrate — A pesticide formulation consisting of a toxicant and an emulsifying agent mixed in water or an organic solvent; the emulsifying agent allows the toxicant to remain dispersed throughout the material.

Endangered Species — A species in danger of extinction; a Federal endangered species is an endangered species that has been listed in 50 CFR 17.11 or 17.12.

Endemic Species — A species prevalent or common to a particular geographic area.

EPA — Environmental Protection Agency (U.S.).

Eradication — Complete elimination of a pest species from a given area.

Estimated Environmental Concentration — Estimated amount of insecticide residue that will be in the environment and available to the organism.

Export crop — A crop grown to sell in another country.

Exposure — The amount of a substance which an organism may be subject to from its environment.

FAO — Food and Agriculture Organization of the United Nations.

FDA — Food and Drug Administration (U.S.).

Fenthion — 0,0-dimethyl 0-[3-methyl-4(methylthio) phenyl] phosphorothioate, an organophosphate insecticide.

Feral — Wild, untamed.

FFDCA — Federal Food, Drug, and Cosmetic Act U.S.).

Fixed Wing Aircraft — Aircraft with unmovable wings; not a helicopter.

Fruit — The reproductive body of a seed plant; also fruit trees.

Fruit Stripping — Removal of infested or potentially infested fruit by hand-picking to reduce Medfly populations.

Fumigant — A volatile substance whose vapor kills insects and other pests.

Gamma Radiation — Electromagnetic radiation of high energy and high frequency; used in insect sterilization.

Guatemala MOSCAMED — The Guatemala component of the MOSCAMED Medfly eradication program.

Habitat — The place where an organism lives.

Hymenoptera — The order of insects which contains ants, bees, and wasps.

IICA — Interamerican Institute for Cooperation on Agriculture/Instituto Interamericano de Cooperacion para la Agricultura.

INAFOR — Instituto Nacional Forestal; The National Forestry Institute, a Guatemalan Government agency.

Integrated Control — Control of a pest (unspecified as to eradication or suppression) through selection, integration, and implementation of control tactics in a systems approach on the basis of anticipated economic, ecological, and sociological consequences.

Integrated Pest Management — Suppression of a pest through selection, integration, and implementation of control tactics in a systems approach on the basis of anticipated economic, ecological, and sociological consequences.

Intertropical Convergence — A distinctive pattern of atmospheric and oceanic currents occurring between the Tropics of Cancer and Capricorn; responsible for the pattern of wet and dry seasons in Guatemala.

Inundative Release — Release of a large number of organisms, as in a sterile insect or biocontrol program.

IPM — See Integrated Pest Management.

IUCN — International Union for Conservation of Nature and Natural Resources.

Jackson Trap — Medfly trap baited with the attractant trimedlure.

Krad — A unit for measuring absorbed doses of gamma radiation; 1,000 rad.

Kytoon — A gas-filled balloon measuring 6-8 ft in length and 3-4 ft in diameter; used to mark boundaries of spray blocks and sensitive sites; colors are white and bright orange.

Label Signal Words — Descriptive human hazard words established by the EPA and assigned according to the EPA toxicity category of a particular product; caution, warning, danger or danger/poison.

Larva — An immature form of an insect.

LC_{50} — Median lethal concentration; bioassay based statistical estimate of the median concentration of a substance in water or air, expressed in milligrams per liter (mg/L) or milligrams per cubic meter (mg/m^3) that would be lethal to 50 percent of the test species.

LD_{50} — Median lethal dose; bioassay based statistical estimate of the median dosage (in milligrams of chemical per kilogram of body weight of the exposed animal) that would be lethal to 50 percent of the experimental population of the test species.

LEL — See Lowest Effect Level.

Lowest Effect Level	The lowest dose level at which toxic effects are observed.
Malaoxon	Oxygen analog of malathion which is a much more potent cholinesterase inhibitor than the parent compound.
Malathion	0,0-dimethylphosphorodithoate diethyl-mercaptosuccinate; an organophosphate insecticide or acaricide.
Malathion Bait Spray	Spray mixture containing a protein bait hydrolysate, a feeding stimulant, and the toxicant malathion.
Margin of Safety (MOS)	The ratio between the NOEL and the estimated human dose level (NOEL/dose); the more positive the MOS value, the lower the health risk.
MB	See Methyl Bromide.
Medfly	Mediterranean fruit fly; *Ceratitis capitata* (Wiedemann).
Methyl Bromide	Bromomethane; a fumigant used in fruit and vegetable fumigation at quarantine stations and ports of entry.
Mexico MOSCAMED	The Mexico component of the MOSCAMED Medfly eradication program.
Mitigative Measure	Action taken to avoid, reduce, minimize, repair, or compensate for an adverse environmental impact.
Monitoring	Sampling program; may refer to Medfly population monitoring or environmental sampling.
MOS	See Margin Of Safety.
MOSCAMED	Mexico-Guatemala organization for eradicating the Medfly from Mexico and Guatemala. (The United States has signed bilateral agreements with Guatemala and with Mexico, and is a full partner in the MOSCAMED Program.)
Mutagen	A substance that tends to increase the frequency or extent of genetic mutations (changes in hereditary material).
NAP	Normal atmospheric pressure.
NCI	National Cancer Institute (U.S.).

Nearctic	Zoogeographical region including the Arctic and Temperate areas of North America and Greenland.
Neotropical	Zoogeographical region including southern Mexico, Central and South America and the West Indies.
Nematodes	Roundworms; some insect-specific parasitic nematodes are studied as potential control tactics for Medfly.
NEPA	National Environmental Policy Act (U.S.).
Natural Enemies	Predators, parasites, and pathogens that cause the death of pests.
Niche	The position or functional status of an organism within its community and ecosystem.
NIOSH	National Institute for Occupational Safety and Health (U.S.).
No Effect Level	The pesticide dosage that causes no observable harm to test animals in chronic toxicity tests; also the no observable effect level (NOEL).
NOEL	See No Effect Level.
Nontarget Organisms	Those organisms (species) that are not the focus of control efforts.
Nu-lure	Protein bait; see protein hydrolysate.
Octanol-Water Partition Coefficient	A measure of the tendency for a compound to accumulate in an organic substance relative to water.
OIC	Officer in charage.
OIRSA	Organismo Internacional Regional de Sanidad Agropecuaria; a regional plant and animal health protection organization. (See CIRSA)
Olotes	Corncobs saturated with malathion bait, to which is added a cotton wick containing the attractant trimedlure; used to attract and kill Medfly.
Oncogen	A substance which causes tumors.
Organophosphate	A class of pesticides derived from phosphoric acid esters.
OSHA	Occupational Safety and Health Administration (U.S.).

OSHA Standard	A minimal standard of pesticide safety for the work place established by the U.S. Occupational Safety and Health Administration.
Ovipositor	Egg-laying structure of female insects; used by Medfly to insert eggs into fruits or vegetables.
Para-pheromone	A synthetic substance which mimics certain properties of a pheromone. (See Pheromone.)
Parasite	An organism which completes its development in or on another organism (the host) without killing it.
Parasitoid	An insect which spends its immature stages in or on another insect, killing it in the process.
Parathion	An organophosphate insecticide more toxic than malathion; not used in the Guatemala MOSCAMED Program.
pH	A measure of acidity or alkalinity of a substance, expressed in mathematical terms as the negative log of the hydrogen ion concentration; values less than 7 are acidic, while values greater than 7 are alkaline.
d-Phenothrin	Synthetic pyrethroid insecticide used in treating conveyances (vehicles) at quarantine stations.
Pheromone	A chemical substance produced by an animal that influences the behavior or development of other individuals of the same species; insect sex attractants are pheromones.
Pollen	A mass of microspores in a seed plant usually appearing as a fine dust; bees use the material as food for their young.
ppb	Parts per billion.
ppm	Parts per million.
Predator	An organism that lives by preying on animals (prey); often used in biological control programs to suppress pest populations.
Protein Hydrolysate	Feeding stimulant for Medfly and other fruit flies used as component in malathion bait spray; furnishes nutrients necessary for sexual maturation; Nu-lure.
Pupa	The stage between the larva and adult of an insect.

Q-Value	The ratio between EEC and the LC_{50} or EC_{50}; the Q-value estimates the risks to aquatic species due to pesticide residuals.
Quarantine	Regulation or action necessary to prevent movement or deny access to pest species; may involve restrictions on production, movement of plants or plant products, animals or animal products, or other material, or commerce.
Rad	A unit for measuring absorbed doses of gamma radiation; 100 ergs/gram.
Reference Dose	See Acceptable Daily Intake.
Respirator	A device worn over the nose and mouth to prevent inhalation of toxic substances.
SIT	See Sterile Insect Technique.
Socioeconomic	Sociological and economic factors considered together.
Sp.	Species, or spp. (plural).
Sterile Insect	The release of sterilized Medfly into Technique infested areas where they mate with wild Medfly; no offspring result from these matings and field populations decline; SIT.
Suppression	Reduction of a pest population, especially to a level that does not produce economically significant crop damage.
Symbiont	An organism in a relationship in which two or more organisms live together in a close association which is not necessarily of benefit to each.
Technical Material	The pesticide chemical in its purest mnufactured form before formulation into a product; usually contains 95-100 percent of the active ingredient.
Temperature Dependent	Varying with temperature; the life cycle of the Medfly varies in length depending on temperature.
Tephritidae	Also called Trypetidae; the family of flies (Diptera) to which the Medfly belongs.
Teratogen	A substance tending to cause developmental malformations or birth defects in unborn humans or animals.
Threatened Species	A species which is threatened with extinction; a Federal threatened species is a threatened species that has been listed in 50 CFR 17.11 or 17.12.

Threshold Dose See Lowest Effect Level.

Threshold Limit Value The concentration of an airborne substance to which workers may be exposed repeatedly, day after day without adverse effect, as adopted by the American Conference of Governmental Industrial Hygienists.

TLV See Threshold Limit Value.

Trade name Trademarked or commercial name of a pesticide, formulation, or associated product.

Trimedlure Synthetic lure used in Medfly traps; a para-pheromone.

ULV See Ultra Low Volume.

Ultra Low Volume A method of application which uses undiluted pesticide, applied at 1/2 gallon or less per acre.

USC United States Code.

USAID United States Agency for International Development.

USDA United States Department of Agriculture.

WHO World Health Organization of the United Nations.

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Appendix 5. Cooperative Agreement #12-16-86-044

COOPERATIVE AGREEMENT

Between

MINISTERIO DE AGRICULTURA DE GUATEMALA
DIRECCION GENERAL DE SERVICIOS AGRICOLAS
LA DIRECCION TECNICA DE SANIDAD VEGETAL

And

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
PLANT PROTECTION AND QUARANTINE

THIS AGREEMENT, made and entered into by and between the Ministerio de Agricultura, Direccion General de Servicios Agricolas, Direccion Tecnica de Sanidad Vegetal, hereinafter called the Cooperator, and the United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, hereinafter called the Service.

WHEREAS, the Service is authorized pursuant to the Act of September 21, 1944, as amended (7.U.S.C. 147a), to cooperate with Governments of Western Hemisphere countries or the local authorities thereof, in carrying out necessary surveys and control operations in those countries in connection with the detection, eradication, suppression, control and prevention or retardation of the spread of plant pests including the Mediterranean Fruit Fly; and

WHEREAS, a Memorandum of Understanding was entered into between the parties hereto, on February 21, 1977, and the Resolution of the Ministry of Agriculture dated May 13, 1977, which authorized the participation of the Department of Vegetable Health in the direction, coordination, and execution of the joint battle against the Mediterranean Fruit Fly are still, in effect, covering cooperative efforts to protect crops from plant pest damage and plant diseases in the Republic of Guatemala and in the United States of America, through the execution of cooperative programs; and

WHEREAS, it is the intent of the parties that this Agreement shall supersede Agreement No. 12-16-5-2467 of July 10, 1981; and

WHEREAS, the objectives of this Cooperative Agreement are to further action that will provide for specific activities to and for the Service, Cooperator and interested parties with regard to Mediterranean Fruit Fly (*Ceratitis capitata* Wied), and provide services that will assist in the execution of the cooperative eradication program of the Mediterranean Fruit Fly; and

WHEREAS, it is necessary for the furtherance of the goals of the Program to assign the day-to-day management of Mediterranean Fruit Fly activities in Guatemala to the Officers of the Direccion Tecnica de Sanidad Vegetal, of DIGESA, Ministry of Agriculture; and

WHEREAS, the Cooperator is equipped or has access to facilities and had and can secure personnel and equipment mutually satisfactory to both parties for this work; and

WHEREAS, it is the intention of the parties hereto that such cooperation covered by this agreement shall be for the mutual benefit of the people of Guatemala and the United States of America.

NOW THEREFORE, for and in consideration of the promises and mutual convenants herein contained, the parties hereto do hereby mutual agree with each other as follows:

A. Cooperator agrees to:

1. To manage and operate the Mediterranean Fruit Fly laboratory located in Guatemala City (Aurora), Petapilla (Chiquimula), the Quality Control facility (Guatemala City), and the new rearing facility at Villa Nueva, in accordance with mutually agreed to plans for rearing, sterilizing, quality control, and emergence operations for field release of Mediterranean Fruit Flies produced in Guatemala or received from other external sources.

2. To provide for free access to the laboratory by service personnel designated to work at these facilities, subject only to restrictions jointly agreed to in advance. To provide office space for all service personnel at a location most advantageous for performance of their duties.

3. To furnish field operation personnel in Guatemala, for carrying out the program activities which are stipulated in the work plan referenced in paragraph C.2 of this agreement.

4. To provide funding for the laboratories and field operations in Guatemala amounting to the agreed upon sum as stipulated in the financial plan referenced in paragraph C.2 of this agreement.

5. To establish and maintain in Guatemala City, Guatemala, a central administrative office which will be responsible for all the procurement, personnel, financial functions, and records for the operation of the laboratories and for the field operations in the Republic of Guatemala, as stipulated in this agreement.

6. To submit to the service narrative, statistical, financial, and administrative reports concerning the laboratories and field operations in the Republic of Guatemala, in accordance with the work and financial plans as referenced in paragraph C.2 of this agreement.

7. To establish a bank account in Guatemala City, Guatemala, into which the service will deposit its share of the funds for the operation of the laboratories and for field operations in the Republic of Guatemala, as agreed upon in the financial plan referenced in paragraph C.2 of this agreement.

8. To require the administrative office in Guatemala City, Guatemala, to monitor the use and need for funds and to request periodically that the service deposit to the bank account in Guatemala City its share of the funds necessary to sustain operations for

periods not to exceed 60 days from the date of request, and to maintain a record of deposits to substantiate the requests for deposits.

9. To provide all maintenance for Service-furnished, nonexpendable property and to permit free access to same at all times by personnel designated by the Service for the purpose of insuring prescribed usage.

10. To procure all supplies, equipment, and services (including construction services) to maintain operations, except for those items not readily available to the Cooperator in Guatemala or available at a prohibitive cost (plu ercent above United States cost). In such event, the Service, upon written request from the Cooperator will provide assistance in purchasing of those items with funds available under this agreement.

11. To provide through the Government of Guatemala duty free entry of all supplies and equipment furnished by the Service or purchased for the Medfly Program under this agreement.

12. To provide transportation of all supplies and equipment to Guatemala from the source of origin if purchased by the Cooperator; if purchased by the Service, from a mutual agreeable location of the Guatemalan border.

13. All financial and other matters relating to the Villa Nueva rearing laboratory, because of unique funding arrangements, will be maintained, operated, and recorded separately from all other laboratory and/or field operations activities as outlined in this agreement.

B. The Service Agrees:

1. To provide funding for the laboratory and field operations in the Republic of Guatemala in the amount agreed upon as stipulated in the financial plan referenced in paragraph C.2 of this agreement.

2. To deposit in a designated bank account in Guatemala City, funds as agreed upon in the financial plan referenced in paragraph C.2. Deposits will be made to cover the Mediterranean Fruit Fly operations in Guatemala, for periods not to exceed 60 days. Deposit of funds will be made subject to appropriation of funds by the U.S. Congress for the purpose of control and eradication of the Mediterranean Fruit Fly, and will not to exceed the dollar amount specified in the work and financial plans referenced in paragraph C.2.

3. To use its facilities to procure supplies and/or equipment in the United States as may be deemed necessary, as stipulated in paragraph A.lO and in accordance with the work and financial plan as stated in C.2 of this agreement.

4. To provide support personnel to serve as technical advisors who will be stationed in Guatemala City.

5. To provide at its own expense additional technical experts for on-site consultation involving mechanical or scientific advice, when it is mutually agreed that such experts could benefit the program.

6. To provide the necessary reporting format for the financial reports required by the Administrative Regional Office at Monterrey, Mexico, and to conduct a review of these records every 3 months.

C. It is Mutually Understood and Agreed:

1. The parties to this cooperative agreement will cooperate to the best interest of the agricultural producers and the general public of the countries of Guatemala and the United States of America.

2. The cooperating parties will develop and furnish a mutually satisfactory work plans and financial plans for conducting a Mediterranean Fruit Fly program, which will outline overall plans for carrying out and funding this program, in accordance with established standards and to the satisfaction of the Cooperator and the Service.

3. The Cooperator will designate a mutually acceptable official and assistant as duly authorized representative for the Direccion Tecnica Sanidad Vegetal for all matters pertaining to this activity. The official will be assigned as the Project Coordinator for the cooperative program.

4. A mutually acceptable official will be designated as the Service's duly authorized representative for all matters pertaining to this activity and assigned as Co-Project Coordinator of the cooperative program.

5. The Technical Advisory Committee constituted of a maximum of three representatives from each party will be formed to evaluate and recommend program changes.

6. The laboratories and field operations will be under the joint direction of the Project Coordinator and the Co-Project Coordinator. In the event the Coordinator and the Co-Project Coordinator cannot agree with regard to the interpretation or application of the present international instrument, the matter shall be referred to the Technical Advisory Committee. If the Technical Advisory Committee cannot agree, the problem shall be resolved through consultation between the Ministry of Agriculture of Guatemala and the United States Secretary of Agriculture.

7. Biweekly meetings involving representatives of the cooperating parties will be held. Minutes of these meetings will be maintained by the Cooperator and distributed to both parties. If necessary, work and financial plans may be amended during these meetings, so long as these changes are not in conflict with the guidance provided by the Technical Committee.

8. That to the maximum extent possible all procurement will be made competitively in a prudent manner, and in accordance with all governing laws of Guatemala and United States as appropriate.

9. To permit USDA employees, as designated by the Service, to serve as Technical Advisors for laboratory and field operations in Guatemala.

10. That the Cooperator and the Service will coordinate visits by official personnel not regularly assigned to the project.

11. That both parties will jointly ensure that security measures are taken to prevent the escape and/or theft of specimens at any biological stage of the Mediterranean fruit fly.

12. The Guatemalan national personnel employed by the Service in Guatemala and identified by the Service at the time of signing of this Agreement shall without a break in employment be afforded the right of:

   a. Being employed by the Government of Guatemala in a position of like status and salary as enjoyed with the Service; and

b. Upon employment be entitled to full indemnification guaranteed under Guatemalan laws.

13. To employ personnel mutually acceptable to the cooperator and the Service.

14. That funds provided by the Service shall not be used for any purchases of non-expendable equipment without specific prior authorization by the Service. Non-expendable equipment purchased from the Cooperator's funds shall remain the property of the Cooperator subject to its disposition. Likewise nonexpendable equipment purchased from funds provided by the Service shall remain the property of the Service, subject to its disposition.

15. The value of equipment and/or supplies furnished by either party shall include purchase cost, freight, taxes (if any), storage costs, costs of permits and any other directly related costs.

16. The Service funding for this cooperative endeavor will be considered to be those funds deposited to the designated bank account in Guatemala City, Guatemala, and those costs as enumerated in paragraph C.2 of this agreement.

17. Mediterranean fruit fly sterile pupae produced as a result of this joint endeavor will be used as and where needed to the mutual benefit of both parties and according to priorities set forth for the prevention of establishment of the Medfly in Mexico, the United States, and its spread and increase in Guatemala.

18. The Service shall not provide reimbursement to the cooperator for any capital improvements made during the effective period of this agreement, except as provided for in the approved work and financial plans.

19. Financial responsibility to be assumed by each party shall be subject to appropriation of funds available to legally cover program expenses.

20. The results of the work herein outlined may be published jointly by the Cooperator and the Service, or by their party and shall be submitted to the other party for suggestions and approval prior to publication. In the event of disagreement, either party may publish results on its own responsibility, giving proper acknowledgment of cooperation.

21. In the event the costs of the program under this agreement are increased or decreased, the total contribution of the parties may be adjusted as mutually agreed upon in advanced by the parties hereto as stipulated in a revised written work and financial plans.

22. All equipment purchased and installed by the Service under the cooperative agreement of July 10, 1981, between the Cooperator and the Service will remain the property of the Service.

23. The patent provision applicable to this agreement, shall be in accordance with Exhibit A, attached hereto and made a part thereof.

24. The Service, the United States, and all of its officers and employees shall not be liable to the Cooperator for the loss of or damage to any equipment or other property of any kind owned, leased, operated, or in the possession or control of the Cooperator or of any officers, employees, or agents, or cooperators of the Cooperator. The Service, the United States, and all of its officers and employees, shall not be liable to the Cooperator for the death or injury of any of the Cooperator's offices, employees, agents, or any other individuals as a result of activities authorized or described by this agreement. The Cooperator shall hold the Service, the United States, and all of its officers and employees harm-

less from liability of any kind or nature including liability arising under the Federal Employees Compensation Act arising from any activities authorized by or described in this agreement, except for liability arising from the negligent act or omission of an employee of the United States Department of Agriculture. In order to hold the Service, the United States, and all of its officers and employees harmless, the Cooperator agrees to indemnify the Service, the United States, and all of its officers, and employees for all liability and costs including the cost of any judgment and the legal and other costs of the defense of the litigation for all liability arising out of the activities authorized by or described in this agreement, except for liability arising from the negligent act or omission of any employee of the United States.

25. That the Comptroller General of the United States or any of his duly authorized representatives and duly authorized of the United States Department of Agriculture shall, until expiration of 3 years after final payment under this agreement, have access to and the right to examine pertinent books, documents, papers, and records of the Cooperator involving transactions related to this agreement. This same right is extended identically to the Secretary of State and to the Agencies of the Ministerio de Agricultura and the Direccion Tecnica de Sanidad Vegetal of Guatemala.

26. No member of or delegate to the U.S. Congress, Resident, Commissioner, or Guatemalan Parliamentary official shall be admitted to any share or part of this agreement or to any benefit to arise therefrom; unless it be made with a corporation for its general benefit.

27. This agreement shall become effective upon date of final signature and shall continue in force until September 30, 1982, subject to renewal in writing by the parties hereto from year to year. Further, this agreement may be amended at any time by mutual agreement of the parties hereto in writing. Either party may terminate this agreement upon 60 days notice in writing to the other party.

28. Upon termination of the cooperative program, all equipment purchased through the use of funds of the Service, including such equipment purchased under the agreement of July 10, 1981, will be returned to the Service subject to its disposition. In addition, the Service at the request of the Cooperator agrees to sell its equipment to the Cooperator, all or in part, and at the price to be agreed upon through joint evaluation.

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
PLANT PROTECTION AND QUARANTINE

Signed by D. Scot Campbell 10/22/81

DEPUTY ADMINISTRATOR Date

MINISTERIO DE AGRICULTURA DE
GUATEMALA DIRECCION GENERAL DE
SERVICIOS AGRICOLAS DIRECCION
TECNICA DE SANIDAD VEGETAL

Signed by Jorge Escabedo 10/22/81

TECHNICAL DIRECTOR Date

EXHIBIT A

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
PATENT DIVISION

Any invention resulting from this cooperative work and made jointly by an employee or employees of the United States Department of Agriculture and the cooperator or an employee or employees of the cooperator shall be fully disclosed, either by publication or by patenting in the United States, and any such United States patent shall either be dedicated to the free use of the people in the territory of the United States or be assigned to the United States of America or be assigned to the cooperator, as many be mutually agreed upon by the parties hereto, provided, that in the event of assignment to the cooperator, the Government shall receive an irrevocable, nonexclusive, royalty-free license under the patent; throughout the world, to practice the invention for all governmental purposes, and, provided further, that nonexclusive, royalty-free licenses shall be issued by the cooperator to any and all applicants technically competent to make use of the patent, provided, that, where the assignment is to the Government, it shall be of the domestic patent rights. Where the domestic patent rights are so assigned, the United States Department of Agriculture shall have an option to acquire the foreign patent rights in the invention on which an application for a United States patent is filed, for any particular foreign country, said option to expire in the event that the Government fails to cause an application to be filed in any such country on behalf of the Government or determines not to seek a patent in such country with six months after the filing of the application for a United States patent on the invention. Where the domestic patent rights are assigned to the Government, but the foreign patent rights are retained by an employee, the employee shall grant to the Government a nonexclusive, irrevocable, royalty-free license in any patent which may issue thereon in any foreign country, including the power to issue sublicenses for use in behalf of the Government and/or in furtherance of the foreign policies of the Government, and said license shall also include the power to sublicense American licenses under Government-owned United States patents to practice the invention without payment of royalty or other restriction in any foreign country wherein a corresponding patent may issue to the employee or his foreign assignee. Any invention made independently by an employee or employees of the United States Department of Agriculture or by the cooperator or an employee or employees of the cooperator shall be disposed of in accordance with the policy of the United States Department of Agriculture or the cooperator respectively, provided that in the event the invention is made solely by an employee or employees of the cooperator, the cooperator shall grant or shall obtain from the assignee of any patent issued on said invention an irrevocable, nonexclusive, worldwide, royalty-free license for the Government, for all governmental purposes, and provided further, in the event the invention is made solely by an employee or employees of the cooperator, that unless the cooperator or his assignee has taken effective steps within three years after a patent issues on the invention to bring the invention to the point of practical application or has made the invention for licensing royalty-free or on terms that are reasonable in the circumstances, or can show cause why he should retain the principal or exclusive rights for a further period of time, the Government shall have the right to require the granting of a license to an applicant on a nonexclusive royalty-free basis.

Appendix 6. Environmental Monitoring Plan—Guatemala MOSCAMED Program

Table of Contents

I. Introduction

This plan provides guidance for gathering data which may be useful in assessing any environmental impacts which may result from aerial applications of malathion bait spray in the Moscamed Program in Guatemala. It includes procedures for collecting samples in three major categories—programmatic, sensitive site, and complaint/emergency. The plan's objectives include:

- Assessing the environmental impacts of the program
- Verifying the efficacy of mitigation measures
- Identifying problems in a timely manner
- Assisting in the enforcement of operating procedures

II. Responsibilities

A. Program Personnel—MOSCAMED or Other Designated program Personnel will:

1. Use the format shown in appendix 1 A; collect base-line data for all programmatic and sensitive sites.*
2. Use the format shown in appendix 1 B; tabulate dates and numbers of pesticide applications made at each programmatic and sensitive site throughout the season.*
3. Use the format shown at appendix 1 C; maintain a list of unique site numbers for pesticide spills.*
4. Collect, document (PPQ Form 602), package, and submit field samples for analysis.

B. National Monitoring and Residue Analysis Laboratory (NMRAL), APHIS. NMRAL Science and Technology (S&T), APHIS personnel will:

1. Input all PPQ Form 602 data to the "Labworks" system, including information in the PPQ Form 602 "Remarks" section, (e.g. programmatic, sensitive-site, or emergency sample; pre-, or post-treatment sample; rainfall amounts and dates; wind speed, unique site number, etc.). Enter raw agricultural commodity names as shown in appendix 3.
2. Maintain sample records in accordance with Environmental Protection Agency's guidelines, *Good Laboratory Practices,* and provide chemical residue analyses in accordance with published, validated, or Association of Official Analytical Chemists pproved procedures. For example,

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* Copies of this information will be maintained at MOSCAMED headquarters and the Animal and Plant Health Inspection Service (APHIS), International Services (IS), Area Office in Guatemala City.

all analytical methods used for determining pesticide residues in or on raw agricultural commodities should be among the methods contained or referenced in the Food and Drug Administration's "Pesticide Analytical Manual" (40 CFR 180.101 (c)).

3. Make results of urgent analyses available to IS-Operational Support (OPS) within 10 calendar days after receipt by NMRAL. Results of all other sample analyses will be made available to IS-OPS, Hyattsville, within 90 calendar days of submission.
4. Electronically transmit residue results and other PPQ Form 602 data to IS-OPS.

C. National Monitoring Coordinator (NMC)—The NMC, S&T Gulfport, Mississippi, will provide field instructions, training, and supplies.

III. General Sampling Procedures And Documentation

A. All Samples

Collect samples in accordance with PPQ manual M390.1403, Pesticide Monitoring Sampling Procedures, and instructions provided in this plan. Describe raw agricultural commodities using the same wording as shown in appendix 3. Number each sample collected at each site with the field number of that site. Site numbers must be unique; i.e., the only site in the *entire program* that has this number. To ensure unique numbers are assigned, use the format: XX-0000-0000 where XX is the State/district abbreviation and the zeros represent work and/or field unit numbers. For spill sites, use XXS as a prefix in place of XX. Securely attach an accurately prepared PPQ Form 602 with each sample.

Indicate in the "Remarks" section of PPQ Form 602:

1. The sample category (i.e. pre-treatment, Treatment season, or post-treatment).
2. The sample type (i.e. Programmatic; Sensitive Site Occupied Building, Drinking Water Source, Park and Recreation, or Endangered Species; and Complaint/Spill/Other Urgent Request).
3. Record any pesticides known to have been applied by the grower or building occupant during the growing season, especially malathion.

B. Complaint or Other Urgent Request Samples

Provide meteorological data if available, particularly any rainfall within 3 days after application. Record this information on the complaint form. If fish are sampled, indicate in the "Remarks" section of the PPQ Form 602 condition of fish were (dead, dying, or apparently healthy). If water samples are to be analyzed for other compounds in addition to malathion, collect and submit a separate water sample and indicate what compound is to be analyzed. Indicate in the "Remarks" section of the PPQ Form 602 that the sample(s) require "Urgent Analysis," and attach a red EMERGENCY SAMPLE sticker to the PPQ Form 602.

Continue to collect and submit samples until residue results reported by the NMRAL are less than EPA-established tolerances for the particular commodity involved (or 135 ppm for unlisted commodities and soils); collect water samples until residue results are less than 10 ppb.

Note: An interim change to M390.1403 requires all samples (including water) to be shipped frozen. Use only water bottles supplied by the NMRAL. In addition, determine the water's pH using field test kits, and acidify if above pH 8.0.

IV. Programmatic and Sensitive-Site Sampling

A. Frequency

1. Pre-treatment samples

Collect samples prior to the first treatment.

2.. Treatment season samples

Collect sample 12 hours following the second treatment.

3. Post-treatment samples

Collect samples, 1 to 12 hours after final treatment.

4. Tank mix sampling

A sample will be drawn from each batch of malathion used in the spray operations. This sample should be obtained at the time that the spray aircraft are loaded. A sample will consist of approximately 2 ml of tank mix. Small glass vials will be supplied as containers. The vials should be clearly labeled with the pesticide lot number and the sample collection date.

B. Programmatic Sampling

Programmatic sampling will assess the environmental impacts of malathion bait spray applications, verify program mitigation measures, identify problems in a timely manner, and assist in the enforcement of designated operating procedures. Collect programmatic samples from as many sites as program resources permit. Ideally, sample at least one site in each work unit.

1. Criteria for site selection

A treatment block is defined as a contiguous area that is sprayed aerially in a single operation. In each treatment block, a monitoring site is to be established. The monitoring site will consist at a minimum from three or more trees or plants, wholly contained within the block, clearly located, identified and designated. It should be located as near to the center of the treatment block as feasible. Once chosen, a monitoring site is to be maintained at the same location for the duration of the treatment operations.

2. Sample components

Collect water and raw agricultural samples when available at the site.

3. How to collect samples

Collect samples as outlined in PPQ manual M390.1403, except as follows:

- **Vegetation**. Take pre-treatment sample 8 hours prior to first treatment. Leaves are to be collected within 12 hours after the first and second application and 8-12 days after the final application.
- **Water.** Take pre-treatment programmatic water samples 24 to 48 hours prior to the first treatment. Collect samples within 12 hours, after the first and second application and 8-12 days after the final application. Record on the PPQ Form 602 the date of the last malathion bait spray application. Where ponds or lakes are not present in a treatment block, water samples can to be obtained from a well or stream within 500 feet of the treatment block.
- **Raw agricultural commodities**. Follow procedures outlined under the Vegetation heading.

C. Sensitive-Site Sample Collection

Sensitive sites include occupied buildings (churches, schools, hospitals, and residences occupied at the time of treatment), lakes, reservoirs, hand-dug wells, parks, recreation areas, and critical or sensitive habitats of Federally listed species endangered, threatened, or of concern that may be adjacent to the treatment area. The purpose of sensitive-site sampling is to collect data to assess the environmental impacts of program applications, verify the efficacy of program mitigation measures, identify problems in quickly, and assist of designated program operating procedures enforcement.

1. Criteria for site selection

Select sensitive sites using the following criteria:

- **Occupied buildings.** Must be within 500 feet of the border of the treatment area.
- **Lakes, reservoirs, and other drinking water sources.** Must be within 500 feet of the border of the treatment block and be used as municipal or private water sources for human consumption. Select one per treatment block.
- **Threatened, endangered, or other species of concern.** Sample habitats of species specifically identified by the responsible agencies as occurring within ¼ mile of the spray block, requiring additional mitigating measures.

2. **Sample components**. The sample components to be collected at each site are listed below. Each collection site may include more than one type of sensitive site. For example, a site may be selected which contains both a pond and an occupied building. Collect the samples following the general guidelines outlined in M390.1403,III. (Other samples, i.e., fish, may be colleted at the discretion of the program manager.)
   - Occupied buildings: Collect leaf samples grown on the premises which are subject to exposure to program treatments (select only leaf samples from items listed in Appendix 3). Permission from the occupant and/or the owner of the building must be granted to take these samples.
   - Lakes, reservoirs, and other water used for drinking: Collect a water sample.
   - Parks and recreation areas: Collect a water sample from recreational water sources within 500 feet of the treatment block.
   - Threatened, endangered, or other species of concern: Federally listed threatened and endangered species have been identified. Specific concerns and protective measures are also found in the environmental analysis. If collections are made, state in the remarks section of the PPQ Form 602 that the sample is associated with an endangered, threatened, or protected species and name the species. The following components may be suggested for sampling:
     a. For aquatics, collect water and aquatic macroinvertebrates, particularly crayfish if available, and fish from that portion of the habitat closest to the spray block.
     b. For non-aquatics, collect samples of the species' food source. For example if the species is a bat, then collect insects using a portable night-light trap (collect for one night immediately following a pre-treatment season, and final malathion bait spray application).

V. Complaint or Other Urgent Request Sampling

The purpose of collecting these samples is to identify problems fast and determine if program pesticides may be present in the sample, thereby confirming or discrediting the merits of a complaint.

A. Sample Components

Sample the environmental component most closely associated with the complaint or request. For example, if a fish kill is alleged, take a sample of water and fish; if a crop is involved, sample that crop.

B. Frequency of Sampling

Collect samples in response to a complaint or other urgent request for sampling as soon as possible after the complaint or request is received.

VI. Optional Samples

This plan establishes the minimum sampling requirements associated with the program.

Appendix 1.

The following formats should be used to collect critical base-line data. You may delete example entries shown and reproduce blank forms locally.

A. Base-Line Data for Programmatic and Sensitive Sample Sites (collect this data once prior to spraying):

1. Site Number*/ Type**	County	Officer-in-Charge Name/ Phone Number	Component*** Direction, Distance/ Size or Species

* Site number must be unique, i.e. the only site in the *entire program* that has this number. Use the format XX-0000-0000 where XX is the State/ district abbreviation and the zeros represent work and field unit numbers.

** Programmatic = P; Sensitive site—occupied building = SS-OB; Sensitive site—drinking water = SS-DW; Sensitive site—parks and recreation areas = SS-PR; Sensitive site—endangered species = SS-ES.

*** Component for programmatic sites is the pond, for sensitive sites it is the occupied building, drinking water source, park and recreation area, or endangered species. Direction is where an observer would look to view the component from approximately the center of the treatment block. If more than half of the component lies within the field, then enter "WITHIN" along with the direction. Distance (in feet) is the approximate distance between the component's edge and the border. Size applies to ponds; species applies to endangered species.

B. Pesticide Application Dates and Cumulative Number of Applications at Programmatic and Sensitive Site:

2. Site Number	Date	#	Date	#	Date	#	Date	#

C. Base-line Data Collection for Pesticide Spill Sites:

Site Number*	County	Officer-in-Charge Name/ Phone Number	Spill Date/ Chemical/ Pounds < (Active ingredient)	Comments

* Must be unique in the entire program. Use the format XXS-0000-0000, where XX is the State/District abbreviation, S indicates a spill, and the zeros represent work and field unit numbers.

Appendix 2. Emergency Spill Procedures

Detailed general procedures appear in M390.1402, PPQ Guidelines for Managing and Monitoring Pesticide Spills.

Whether contractors, suppliers, or program personnel are responsible for dumps or spills, OICs should ensure the appropriate steps are taken regarding malathion "releases."

"Release" means any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment. Release does not mean application of a registered pesticide in accordance with its label instructions.

Appendix 3. Malathion Residue Tolerances in Agricultural Commodities

Commodity	Tolerance (ppm)	CFR
Alfalfa (pre-h)	135.00	180.111
Almonds (pre & post-h)	8.00	180.111
Almonds, Hulls (pre- & post-h)	50.00	180.111
Apples (pre-h)	8.00	180.111
Apricots (pre-h)	8.00	180.111
Asparagus (pre-h)	8.00	180.111
Avocados (pre-h)	8.00	180.111
Barley, Grain (pre & post-h)	8.00	180.111
Beans (pre-h)	8.00	180.111
Beets (inc. tops) (pre-h)	8.00	180.111
Beets, Sugar, Roots (pre-h)	1.00	180.111
Beets, Sugar, Tops (pre-h)	8.00	180.111
Blackberries (pre-h)	8.00	180.111
Blueberries (pre-h)	8.00	180.111
Boysenberries (pre-h)	8.00	180.111
Brassica (cole) Leafy Vegetables	8.00	180.111
Carrots (pre-h)	8.00	180.111
Chayote	8.00	180.111
Chayote, Roots	8.00	180.111
Cherries (pre-h)	8.00	180.111
Chestnuts (pre-h)	1.00	180.111
Citrus, Pulp, Dehydrated (ct.f.)	50.00	186.3850
Clover (pre-h)	135.00	180.111
Corn (inc. Sweet (k+cwhr)) (pre-h)	2.00	180.111
Corn, Forage (pre-h)	8.00	180.111
Corn, Grain (post-h)	8.00	180.111
Cotton, Seed (pre-h)	2.00	180.111

Cowpeas, Forage (pre-h)	135.00	180.111
Cowpeas, Hay (pre-h)	135.00	180.111
Cranberries (pre-h)	8.00	180.111
Cucumbers (pre-h)	8.00	180.111
Currants (pre-h)	8.00	180.111
Dates (pre-h)	8.00	180.111
Dewberries (pre-h)	8.00	180.111
Eggplant (pre-h)	8.00	180.111
Eggs	.10	180.111
Figs (pre-h)	8.00	180.111
Filberts (pre-h)	1.00	180.111
Flax, Seed.	10.00	180.111
Flax, Straw	1.00	180.111
Garlic (pre-h)	8.00	180.111
Gooseberries (pre-h)	8.00	180.111
Grapefruit (pre-h)	8.00	180.111
Grapes (pre-h)	8.00	180.111
Grasses (pre-h)	135.00	180.111
Grasses, Hay (pre-h)	135.00	180.111
Guavas (pre-h)	8.00	180.111
Horseradish (pre-h)	8.00	180.111
Kumquats (pre-h)	8.00	180.111
Leeks (pre-h)	8.00	180.111
Lemons (pre-h)	8.00	180.111
Lentils (pre-h)	8.00	180.111
Lespedea, Hay (pre-h)	135.00	180.111
Lespedeza, Seed (pre-h)	8.00	180.111
Lespedeza, Straw (pre-h)	135.00	180.111
Limes (pre-h)	8.00	180.111

Loganberries (pre-h)	8.00	180.111
Lupine, Hay (pre-h)	135.00	180.111
Lupine, Seed (pre-h)	8.00	180.111
Lupine, Straw (pre-h)	135.00	180.111
Macadamia Nuts (pre-h)	1.00	180.111
Mangoes (pre-h)	8.00	180.111
Melons (pre-h)	8.00	180.111
Mushrooms (pre-h)	8.00	180.111
Nectarines (pre-h)	8.00	180.111
Oats, Grain (pre & post-h)	8.00	180.111
Okra (pre-h)	8.00	180.111
Onions (pre-h)	8.00	180.111
Onions, Green (pre-h)	8.00	180.111
Oranges (pre-h)	8.00	180.111
Papayas (pre-h)	1.00	180.111
Parsnips (pre-h)	8.00	180.111
Passion Fruits (pre-h)	8.00	180.111
Peaches (pre-h)	8.00	180.111
Peanuts (pre & Post-h)	8.00	180.111
Peanuts, Forage (pre-h)	135.00	180.111
Peanuts, Hay (pre-h)	135.00	180.111
Pears (pre-h)	8.00	180.111
Peas (pre-h)	8.00	180.111
Peas, Vines (pre-h)	8.00	180.111
Peas, Vines, Hay (pre-h)	8.00	180.111
Pecans (pre-h)	8.00	180.111
Peppermint (pre-h)	8.00	180.111
Peppers (pre-h)	8.00	180.111
Pineapples (pre-h)	8.00	180.111

Appendix 7. Guidance to Beekeepers (Translation)

MEMORANDUM OF UNDERSTANDING

MOSCAMED PROGRAM - BEEKEEPER

This ____________ day of ____________ of 199_, at ________ hours, we have met with Mr. ____ who attends the apiary property of ______________________________ located on the treatment block No. __________ farm ______________ ___________________, town _______________________________________ department (= county) ______________________________________. As part of the MOSCAMED program, the attendees verify that there are ________ hives present in this apiary. In accordance with the attached guide and the hereto determined number of hives, material will be provided and delivered for the protection and nourishment of the apiary during aerial applications for the eradication of the Mediterranean fruit fly.

1) __________________________ muslin tarp with window screening
2) __________________________ pounds of sugar
3) __________________________ metal window screening material
4) __________________________ nylon to cover muslin tarp
5) __________________________ jute bagging
6) __________________________ strips of wood

As part of the program, the signatory beekeeper promises to carry out the protective measures according to the recommendations given by the MOSCAMED Program.

If for some reason, these instructions are not carried out, the MOSCAMED Program will be exempt of damage sustained by the apiary

______________________________	______________________________
(Signature) (Date)	(Signature) (Date)
Received by Beekeeper	Delivered by MOSCAMED Program Representative

APIARY INVENTORY

RECORD OF BEEKEEPER

Owner:____
Name of beekeeper:____
Quadrant:_________; Sub-quadrant__________; Coordinate__________;
Farm or place:____
City:___________________; Department (County):__________________;
No. of beehives:________________; Block:_______________________;
Migratory apiary: Yes:_________; No:_________;
Where do you move your
beehives:___________________________________
Production of honey:_______________: Pollen:_____________________
Wax:____________; Royal Jelly:____________; Propolis:___________;
Cycle of honey harvest: 1st:________; 2nd:________; 3rd:________;
4th:_________; 5th_________; 6th_________;
Where do you sell your
products:___________________________________
Other types of revenue:____
Do you belong to any Cooperative or Association: Yes:___; No:___
Name:____
Location:____
Do you change your queens: Yes:____; No:____
How often:____
Observations:____
____
____
____

____ ____________________
(Person submitting inventory) (Date)

AFFIDAVIT NO._____

On the ________day of ________, 199_, at _______hours and ______ minutes, present in the apiary of Mr.___________________________, located on the spray (treatment) block # _______; farm __________, village ________________________ , ________________________ city, ___________________________department (county), representing this apiary, Mr.____ and representing MOSCAMED, Mr.______________________________________. The objective is to evaluate the state of the beehives after the aerial application conducted on the _________; day of __________, 199_, by the MOSCAMED Program.

Evaluation procedures:

<u>First</u>: The number of existing hives was counted, and it was determined that there were _______ hives with 3 layers, _______ hives with 2 layers, and _______ hives with 1 layer.

<u>Second</u>: Mortality of the beehive was observed to be: normal:_______; high:_______; low:_______

<u>Third</u>: Hive activity was observed and was found to be: normal:_______; regular:_______; bad:_______

<u>Fourth</u>: The parties present inspected ______ beehives with the objective to determine if they were contaminated with any disease. It was observed that there existed the presence of: ____
____
____

<u>Fifth</u>: By signing this document, the representatives present hereby agree to this determination at ________hours, and ________minutes in the same place & date.

_____________________________	_____________________________
Beekeeper Name & date	MOSCAMED Program Name & date

PROCEDURES FOR APIARY PROTECTION

a. A combination of protection methods will be used with the primary one being hive covers made of jute bagging and plastic sheeting (see fig. no. 1, 2, & 3).

b. A census of hives within the treatment area will be carried out to determine the location and size of apiaries. A buffer zone of 150 m radius around designated apiaries will be established to provide an additional margin of security against the possibility of chemical drift due to wind.

c. Above each large apiary (greater than 20 hives) a red marker balloon will be placed so that the program aircraft will not discharge malathion bait spray directly over them.

d. The delivery of protective materials, supplemental nourishment, treatment schedule, and written protection guide will be achieved one week before the treatment in compliance with the Memorandum of Understanding.

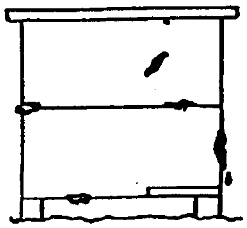
e. One pound of sugar per hive per application will be provided to nourish the bees during confinement at the time of the treatment.

f. Each apiary will be supervised during and after the treatment to determine if the recommendations of the apiary assistance and development personnel were taken into account. This will help to determine whether problems exist at the apiary (an affadavit will be signed for verification).

g. The hives will remain closed and covered on the day of the treatment.

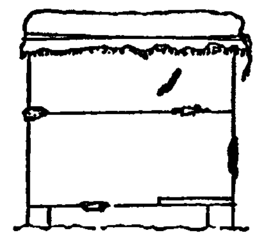
h. Should a beekeeper, for whatever reason, want to move their apiaries outside of the treatment area, the MOSCAMED program will cover the round trip expenses for labor and transportation. Any problems which arise during the move will be the sole responsibility of the beekeeper.

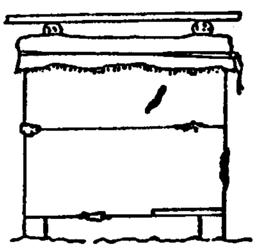
GUIDE FOR THE PROTECTION OF APIARIES USING JUTE SACKS



① AS PART OF YOUR PREPARATION, COVER ANY HOLES IN THE HIVE WITH MUD.

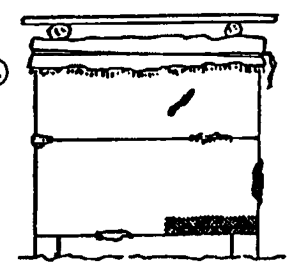
② ONE DAY BEFORE THE TREATMENT, PLACE THE JUTE BAG OVER THE TOP OF THE FRAMES AND TIE IT WITH A CORD.

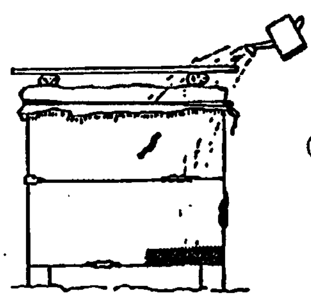




③ NEXT, PUT ROCKS OR PIECES OF WOOD ON TOP OF THE BAGGING AND PLACE THE ORIGINAL TOP OF THE HIVE OVER THIS.

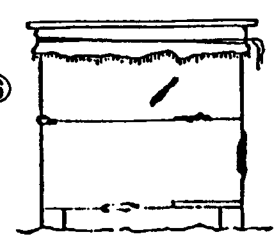
④ AT NIGHT COVER THE ENTRANCE TO THE HIVE WITH A STRIP OF FINE MESHED SCREEN (WINDOW SCREEN)





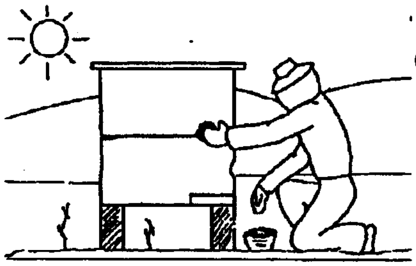
⑤ DURING THE PERIOD OF CONFINEMENT, SPRINKLE THE ENTRANCE AND JUTE BAG WITH WATER (2 OR 3 TIMES PER DAY).

⑥ THE DAY AFTER EACH TREATMENT, UNCOVER THE HIVE AT NIGHT, LEAVING THE JUTE BAGGING IN PLACE WITHOUT ROCKS OR PIECES OF WOOD TO HOLD IT DOWN.



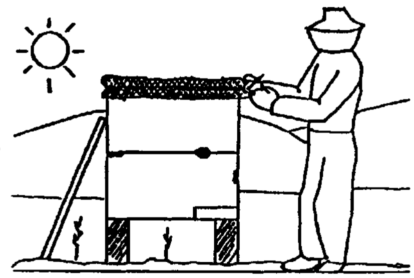
YOUR WELL PROTECTED HIVES WILL PERMIT US TO CONDUCT OUR WORK WITHOUT CAUSING YOU PROBLEMS.

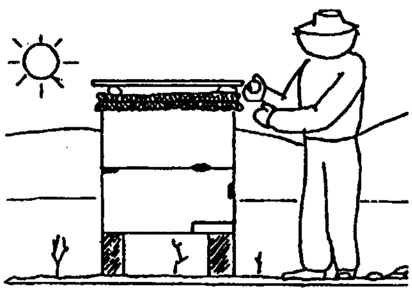
GUIDE FOR THE PROTECTION OF INDIVIDUAL HIVES USING JUTE SACKS



① AS PART OF YOUR PREPARATION, COVER ANY HOLES IN THE HIVE WITH MUD.

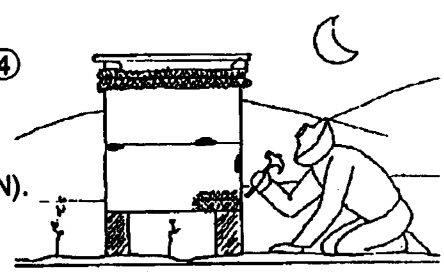
② ONE DAY BEFORE THE TREATMENT, PLACE THE JUTE BAG OVER THE TOP OF THE FRAMES AND TIE IT WITH A CORD.

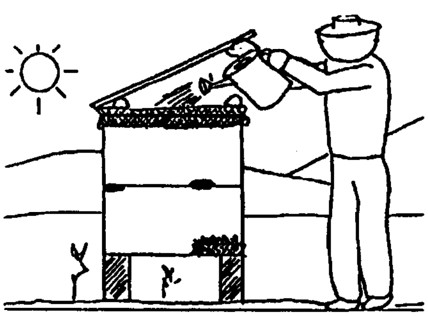




③ NEXT, PUT ROCKS OF PIECES OF WOOD ON THE TOP OF THE BAGGING AND PLACE THE ORIGINAL TOP OF THE HIVE OVER THIS.

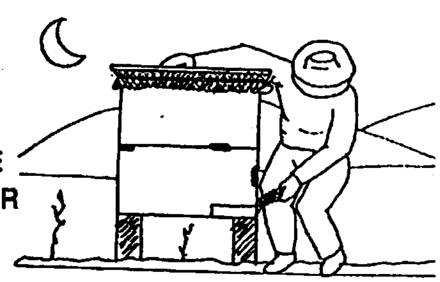
④ AT NIGHT COVER THE ENTRANCE TO HIVE WITH A STRIP OF FINE MESHED SCREEN (WINDOW SCREEN).



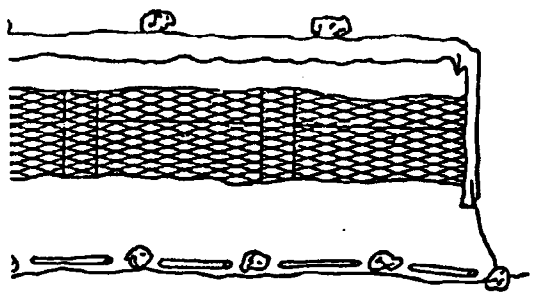


⑤ DURING THE PERIOD OF CONFINEMENT, SPRINKLE THE ENTRANCE AND JUTE BAG WITH WATER (2 OR 3 TIMES PER DAY)

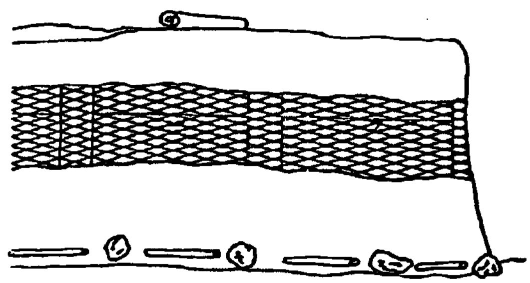
⑥ AFTER EACH TREATMENT, UNCOVER THE HIVE AT NIGHT, LEAVING THE JUTE BAGGING IN PLACE WITHOUT ROCKS OR PIECES OF WOOD TO HOLD IT DOWN.



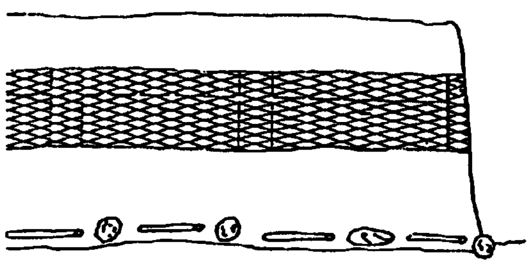
GUIDE FOR THE PROTECTION OF MULTIPLE HIVES OR APIARIES USING PLASTIC SHEETS OVER SCREENED CANVAS



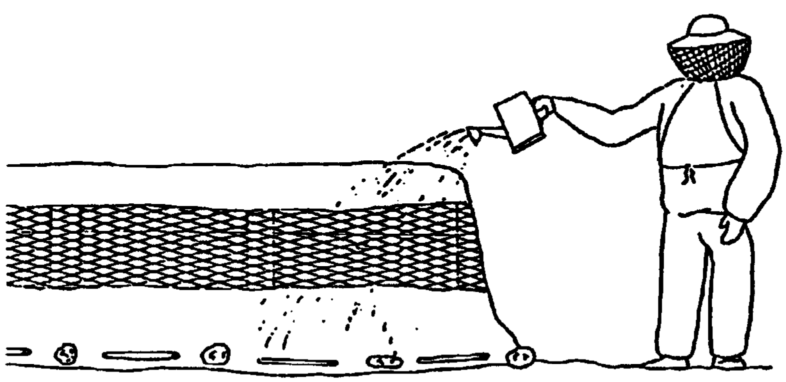
① PLACE PLASTIC SHEETING OVER THE CLOTH AND SECURE IT WITH A HEAVY OBJECT.



② ON THE DAY OF TREATMENT AFTER THE PLANES OR HELICOPTERS HAVE PASSED, TAKE OFF THE PLASTIC COVER, WASH IT, AND PUT IT AWAY.



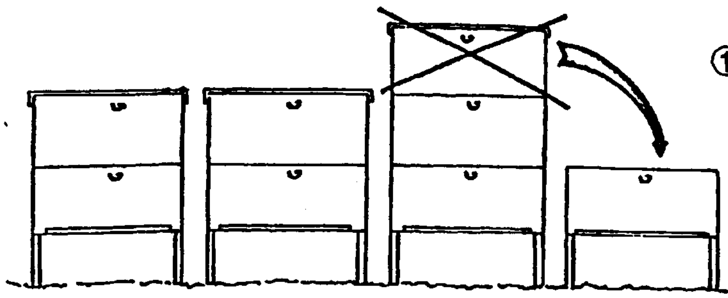
③ LEAVE YOUR HIVE COVERED THIS WAY FOR THE DAY OF THE TREATMENT.



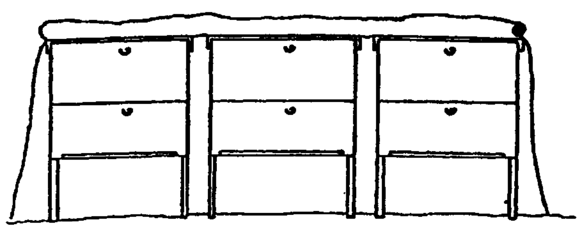
④ DURING THE TIME THE BEEHIVES ARE ENCLOSED, WATER THE SHEET AT THE FRONT OF THE ENTRANCES.

YOUR WELL PROTECTED BEEHIVES WILL PERMIT US TO DO OUR JOB WITHOUT CAUSING YOU ANY PROBLEMS.

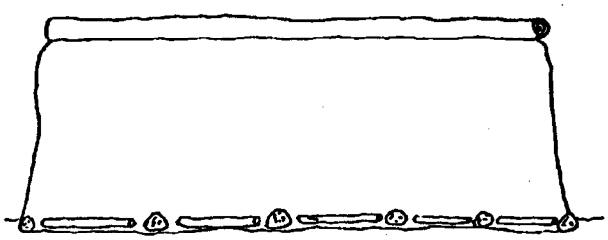
GUIDE FOR THE PROTECTION OF MULTIPLE HIVES OR APIARIES USING SCREENED CANVAS



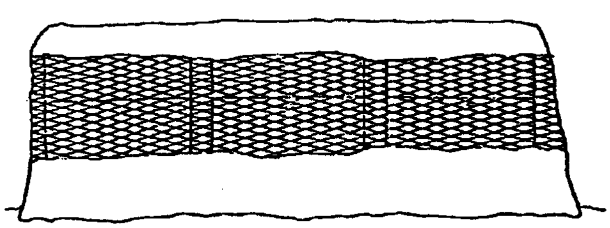
① ONE DAY BEFORE THE TREATMENT, LEVEL YOUR BEEHIVES IN A MANNER THAT WILL KEEP THEM WITH ONE BROOD CHAMBER AND ONE SUPER OF HONEY.



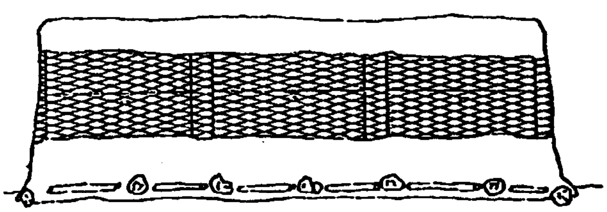
② PLACE THE CLOTH OVER THE HIVES THAT ARE IN A ROW.



③ SECURE THE BACK AND SIDES OF THE CLOTH WITH ROCKS AND/OR PIECES OF WOOD.



④ AT NIGHT LOWER THE FRONT CLOTH SO THAT THE SCREEN WILL BE IN FRONT OF THE ENTRANCES OF YOUR HIVES.



⑤ SECURE THE FRONT OF THE CLOTH WITH ROCKS OR PIECES OF WOOD.

Appendix 8. Endangered and Threatened Species of Guatemala

The Animal and Plant Health Inspection Service (APHIS) has used information from a variety of sources to develop a consolidated listing of species which are endangered, threatened, proposed, or of concern to Guatemala. This analysis and the following biological assessments includes species which have been listed for Guatemala: (1) by the Government of Guatemala, (2) under the Endangered Species Act of 1973 (United States), (3) under the International Council for Bird Preservation, (4) by commenters on the APHIS Draft Environmental Analysis of the Guatemala MOSCAMED Program, (5) by the Consortium for International Crop Protection's Environmental Impact Analysis, or (6) by APHIS.

A principal resource for determination of the endangered or threatened status of Guatemalan species is the Endangered Species Act of 1973 (ESA). ESA was passed to provide for a federal mechanism to protect threatened and endangered species. ESA provides procedural guidance for the biological assessment of endangered and threatened species. This procedural guidance may or may not be applicable to United States federal actions in other countries, depending upon the interpretation of the courts in cases now being adjudicated in the United States. The biological assessments provided within this analysis are designed to meet the procedural requirements of ESA.

The biological assessment for each species includes the common and scientific names of the species, notes relative to any questions on taxonomic status, regulatory status, pertinent species information (biology, habitat, and life cycle), an assessment of potential environmental effects attributable to the program, and a conclusion. Under the status heading, species which have been listed as threatened, endangered, or proposed under the provisions of ESA are identified as being "federally listed," and citations are provided for the Federal Register notices and corresponding dates of the listings.

There has been a determination of "no effect" for all species which are listed as endangered, threatened, proposed, or of concern to Guatemala. In general, the no effect determination for most of those species was made because they inhabit remote parts of Guatemala which are not part of the program area at all. Still others of the species inhabit separate ecological niches or habitats within program areas which are not subject to program treatments or effects, or are protected by specific protection measures such as buffer zones.

A. Endangered and Threatened Mammals of Guatemala

1. Mantled howler monkey (*Alouatta palliata*)

Status

The mantled howler monkey, *A. palliata* was federally listed as an endangered species in 41 FR 24064 (June 14, 1976).

Pertinent species information: Howlers are the largest of the New World monkeys. The length of the head and body is 559 to 915 millimeters and the length of the tail is 585 to 915 millimeters. The adult weight ranges from 7 to 9 kilograms. The hair is coarse, the face is naked, and in some species the hair is long on the head and shoulders.

The known record longevity for the genus *Alouatta* is held by a mantled howler which lived in captivity for at least 20 years on Barro Colorado Island.

Group size in mantled howlers varies from 2 to 45, with each group containing 2 to 4 adult males and 5 to 10 adult females. Breeding seems to take place throughout the year, and normal litter size is one. The estrous cycle is 13-24 days and the gestation period is 180-94 days.

The diet of *A. palliata* is varied consisting mainly of leaves (48.6%), fruit, some beetle larvae, and other vegetable matter. This genus eats more leaves than any other New World monkey.

This animal may be found from southern Mexico to Columbia and eastern Ecuador. Mantled howlers are arboreal and mainly diurnal forest dwellers. *A. palliata* prefers primary forest and usually avoids scrub forest.

Assessment

Populations of howler monkeys have declined as a consequence of hunting, deforestation, and collecting for commercial export.

Concerns over potential adverse effects of the program to the mantled howler monkey relate to the program's potential to affect its food supply. For example, residues of malathion bait spray could be expected to persist for a short period of time on the leaves that constitute the main staple of the mantled howler's diet. Since primary forest areas and, especially, the Tikal Region of Guatemala will not be treated, there is no potential for adverse effect on the species. No effect would be projected for the use of olotes (not attractive to howlers), sterile insect technique, or fruit stripping, even if habitat and treatment areas coincided.

The Guatemala MOSCAMED Program is not expected to affect the mantled howler monkey because the remote geographical areas that it inhabits do not coincide with projected treatment areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the mantled howler monkey.

2. Black howler monkey (*Alouatta pigra*)

Status

The black howler monkey, *A. pigra*, was federally listed as an endangered species in 41 FR 45993 (October 19, 1976).

Pertinent Species Information

The black howler monkey is found in remote tropical rainforest regions of Guatemala, Belize, and Mexico.

Howlers are the largest of the New World monkeys, with combined head and body length up to 915 millimeters and tail length up to 915 millimeters. The adults weigh from 7 to 9 kilograms. Their size probably contributes to their vulnerability to hunting and collecting pressures. Howler monkeys' hair is coarse, the face is naked, and in some species the hair is long on the head and shoulders.

Black howlers are arboreal and mainly diurnal forest dwellers. Group sizes in black howlers varies from 4 to 6 and shows a tendency towards monogamy, having one-male groups (Bolin, 1981). The estrous cycle is 13 to 24 days, gestation is 187 days, breeding seems to take place throughout the year, and normal litter size is one.

The diet of *A. pigra* is varied, consisting mainly of leaves (48.6%), fruit, beetle larvae, and other vegetable matter. Compared to the diets of other New World monkeys, howlers' diets contain a greater percentage of leaves.

Assessment

Populations of howler monkeys have declined as a consequence of hunting, deforestation, and collecting for commercial export.
A. pigra also have declined due to competition with the mantled howler monkey (*A. palliata*), which is more able to adapt to secondary and disturbed forests.

Concerns over potential adverse effects of the program to the black howler monkey relate to the program's potential to affect its food supply. For example, residues of malathion bait spray could be expected to persist for a short period of time on the leaves that constitute the main staple of the mantled howler's diet. Since its rainforest habitat will not be treated, there is no potential for adverse effect on the species. No effect would be projected for the use of olotes (not attractive to howlers), sterile insect technique, or fruit stripping, even if habitat and treatment areas coincided.

The Guatemala MOSCAMED Program is not expected to affect the black howler monkey because the remote geographical areas that it inhabits do not coincide with projected treatment areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the black howler monkey.

3. Spider monkey (*Ateles geoffroyi*)

Status

Two subspecies of spider monkeys, *A. geoffroyi frontatus* and *A. geoffroyi panamensis* were federally listed as endangered in 35 FR 8495 (June 2, 1970).

Pertinent Species Information

In Guatemala, the spider monkey may be found in Tikal, Peten, and Uaxactum. Spider monkeys are found in rain and montane forests and tend to occupy small branches of the high strata of the canopy.

The diet of *Ateles* consists largely of fruit (ramon), supplemented by nuts, seeds, buds, flowers, leaves, insects, arachnids, and eggs. They feed mostly in the morning and rest the remainder of the day.

Spider monkeys are arboreal and diurnal, tending to spend most of their day resting. However, when active only gibbons exceed *Ateles* in agility in trees. They move swiftly through trees and use their tails as a fifth arm or leg. When approached, spider monkeys sometime break off dead branches weighing nearly 5 kilograms and drop them, attempting to hit the observer.

Group size varies considerably, especially in response to habitat condition. Aggregations of up to 100 individuals have been reported; however, the usual size is 2 to 30. There is no regular breeding season, the estrous cycle is 24 to 27 days, and the gestation period is 226-232 days. Normal litter size is one, interbirth intervals are 3 years, and sexual maturity is attained at 5 years in males and 4 years in females. Individuals of this species average a lifespan of 20 years in the wild, but some have lived up to 33 years in captivity.

Assessment

The spider monkey is thought to be endangered as a result of extensive hunting, collection for commercial exportation, and deforestation.

Concerns over potential adverse effects of the program to the spider monkey relate to the program's potential to affect its food supply. Depending upon the treatment alternative, some malathion bait residue could persist for a short time on the leaves that are the main source of food for the spider monkey. However, this would not affect the spider monkey so long as the program treatment area and habitat did not coincide. No effect would be projected for the use of elotes (not attractive to spider monkeys) or sterile insect technique even if habitat and treatment areas coincided.

The Guatemala MOSCAMED Program is not expected to affect the spider monkey because the geographical areas that it inhabits do not coincide with projected program treatment areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the spider monkey.

4. Cougar, puma, panther, or mountain lion (*Felis concolor*)

Status

The cougar is a species of concern to Guatemala. Subspecies including the eastern cougar and Costa Rican puma have been federally listed as endangered species.

Pertinent Species Information

The cougar has the greatest natural distribution of any mammal in the Western Hemisphere, except for man. Several subspecies, including the eastern cougar and Costa Rican puma, are now endangered but have never had a historic range in Guatemala. In Guatemala it inhabits remote areas, generally far from human habitation.

The cougar is the largest species in the genus *Felis*. Adult males have a combined head and body length ranging from 1,050 to 1,959 millimeters, tail length from 660 to 784 millimeters, and weight from 67 to 103 kilograms.

The cougar inhabits a wide range of habitat, including: montane coniferous forests, lowland tropical forest, swamps, grassland, dry brush country, or any other areas with adequate cover and prey. There is usually no fixed den, except as used by females to rear young. Temporary shelter is taken in such places as dense vegetation, rocky crevices, and caves.

The cougar (puma) is agile and is able to climb and swim well. Sight is the most acute sense, and hearing is also good. The species exhibits both nocturnal or diurnal behavior. There is no specific breeding season, but in North America most births occur during winter. Estrous lasts about 9 days and gestation is 90 to 96 days.

Assessment

The Guatemala MOSCAMED Program is not expected to affect the cougar because the species' remote habitat will not coincide with program treatment areas.

The Guatemala MOSCAMED Program is not expected to affect the cougar because the remote geographical areas for which it inhabits do not coincide with projected treatment areas. The program is not expected to affect the cougar, its habitat, or its prey base.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the cougar.

5. Ocelot (*Felis pardalis*).

Status

The ocelot was federally listed as an endangered species in 37 FR 6476 (March 30, 1972) and 47 FR 31670 (July 21, 1982).

Pertinent Species Information

In Guatemala, the ocelot inhabits remote areas, generally away from human habitation. The ocelot has been recorded from Arizona and Texas to northern Argentina in a variety of habitats ranging from humid tropical forests to fairly dry scrub country. The subspecies *F. p. albescens* probably once ranged over most of Texas and at least as far east as Arkansas and Louisiana. Fewer than 1,000 individuals are thought to survive, and fewer than 100 of those are in Texas.

The ocelot is a small to medium sized spotted cat. It's combined head and body length ranges from 550 to 1,000 millimeters, tail length from 300 to 450 millimeters, and weight from 11.3 to 15.8 kilograms.

Ocelots are generally nocturnal, sleeping by day in hollow trees, in thick vegetation, or on branches. They are mainly terrestrial, but climb, jump, and swim well. Ocelots prey on rodents, rabbits, young deer and peccaries, birds, snakes, and fish.

There is probably no identifiable breeding season in the tropics (Grzimek, 1975), but in Mexico and Texas, young are born in the fall and winter (Leopold, 1959). The gestation period is 70 days and there are usually two young but occasionally as many as four. An individual has lived for 20 years and 3 months in captivity.

Assessment

The ocelot still occurs over much of its historical range. The decline of the ocelot has been attributed primarily to destruction of its habitat (clearing of brush country for agricultural purposes) and hunting for its fur.

The Guatemala MOSCAMED Program is not expected to affect the ocelot because the remote geographical areas which it inhabits do not coincide with program treatment areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the ocelot.

6. Guatemala margay (*Felis wiedii salvinia* Pocock)

Status

The margay was federally listed as an endangered species in 37 FR 6476 (March 30, 1972).

Pertinent Species Information

The margay was found originally from the southwestern United States to Central and South America, and as far as northern Argentina. The Guatemala margay, *Felis wiedii salvinia*, is distributed in Guatemala and possibly Belize. Margays shun open country and are generally found in remote areas far from human habitation.

Margays are spotted cats, about the size of a large house cat. Margays are more nocturnal and solitary than ocelots. They are primarily, if not exclusively, forest dwellers and are the most arboreal of the Neotropical cats. Margays prey on monkeys, arboreal rodents, birds, lizards, and insects, but also eat fruit. Margays have an extremely low basal rate of metabolism among carnivores that prey on other vertebrates, perhaps because of their mixed diet.

Adults probably reach sexual maturity at about 2 years of age. Litter size is one or two. The breeding season varies with the environment, and births occur from about March to June.

Assessment

The margay has become rare throughout much of its range because of destruction of its habitat. Although it has been hunted and trapped for its pelt, the margay has not been subject to as much pressure as the ocelot, which has a larger pelt.

The Guatemala MOSCAMED Program is not expected to affect the Guatemala margay because the remote areas it inhabits do not coincide with program treatment areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the Guatemala margay.

7. Jaguarundi (*Felis yagouaroundi*), including the following subspecies: *F. y. cacomitli*, *F. y. fossata*, *F. y. tolteca*, and *F. y. panamensis*.

Status

The jaguarundi, including the four named subspecies, was federally listed as an endangered species in 41 FR 24064 (June 14, 1976).

Pertinent Species Information

In Guatemala, the jaguarundi inhabits remote areas, generally away from human habitation. The historical range for the jaguarundi is from southern Arizona and southern Texas to Northern Argentina. The jaguarundi is not known to survive now in Arizona, and only a few individuals are thought to survive in Texas.

The jaguarundi's combined head and body length ranges from 550 to 770 millimeters, tail length from 330 to 600 millimeters, and weight ranges from 4.5 to 9 kilograms. There are two color phases: blackish to brownish gray, and fox red to chestnut. The jaguarundi has a slender and elongate body and is said to resemble a weasel or an otter in appearance.

The jaguarundi inhabits lowland forests and thickets. It hunts in the morning and evening, and is much less nocturnal than most cats. It forages mainly on the ground, but is an avid tree climber. The diet includes birds and small mammals.

There is no specific breeding season, but in Mexico young are born in March and August. It is not known whether one female gives birth in both seasons. The gestation period is 63 to 70 days with two to four young per litter.

Assessment

The jaguarundi is widespread and not subject to commercial exploitation. Its pelt is of poor quality and of little value. The jaguarundi is generally shy and avoids human contact.

The Guatemala MOSCAMED Program is not expected to affect the jaguarundi because the remote geographical areas for which it inhabits do not coincide with projected treatment areas. The program is not expected to affect the jaguarundi, its habitat, or its prey base.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the jaguarundi.

8. Mexican long-nosed bat (*Leptonycteris nivalis*)

Status

The Mexican long-nosed bat was federally listed as an endangered species in 53 FR 38460 (September 30, 1988).

Pertinent Species Information

The Mexican long-nosed bat originally occurred from southwestern Texas and perhaps southwestern New Mexico, throughout much of Mexico, to Guatemala. The only record of its occurrence in Guatemala is based entirely on two specimens collected over 100 years ago.

Assessment

The Mexican long-nosed bat has a head and body length of 70 to 90 millimeters and weighs 18 to 30 grams. Coloration is usually yellowish-brown or grayish above and cinnamon brown below. In the field it is difficult to distinguish Sanborn's long-nosed bat from the Mexican long-nosed bat (*L. nivalis*) because they differ little in size. However, upon closer observation the two can be separated by cranial and dental characteristics.

The Mexican long-nosed bat is adapted for life in arid country, and is found in desert scrub habitats as well as at high elevations on wooded mountains. The bats depend almost entirely on caves and abandoned mines and tunnels for daytime roosting sites. Thousands may roost together at a single site.

At night these bats emerge from roosting sites to feed on nectar and pollen. Large cacti and flowers of paniculate agaves (century plants) which produce showy, easily accessible, night-blooming flowers that are high in protein are especially favored by these bats. The muzzles and tongues of the Mexican long-nosed bat are highly adapted in both length and surface structure for deep insertion into flowers and collection of pollen particles. When a bat visits a flower, the bat not only laps up some of the nectar and pollen on the spot, but picks up a considerable amount of pollen on its fur for later consumption. The bats also consume soft and juicy types of fruit. Mexican long-nosed bats are easily disturbed and readily take flight when disturbed.

Assessment

Because the Mexican long-nosed bat has not been observed in Guatemala for over 100 years, it is unlikely that this species still inhabits Guatemala. Accordingly, the Guatemala MOSCAMED Program will have no effect on the Mexican long-nosed bat.

However, even if the Mexican long-nosed bat were still found in Guatemala, it would not be directly exposed to Guatemala MOSCAMED Program activities because of the its daytime roosting behavior and nocturnal activity.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the Mexican long-nosed bat.

9. Sanborn's long-nosed bat *(Leptonycteris sanborni)*

Note

This species has a rather confusing nomenclatural history. It is considered synonymous with *L. yerbabuenae*.

Status

Sanborn's long-nosed bat was federally listed as an endangered species in 53 FR 38460 (September 30, 1988).

Pertinent Species Information

Sanborn's long-nosed bat is found from the southwestern United States through Mexico, and into Central America to El Salvador.

The Sanborn's long-nosed bat has a head and body length of 70 to 90 millimeters and weighs 18 to 30 grams. Coloration is usually yellowish-brown or grayish above and cinnamon brown below. In the field it is difficult to distinguish Sanborn's long-nosed bat from the Mexican long-nosed bat (*L. nivalis*), because they differ little in size. However, upon closer observation, the two can be separated by cranial and dental characteristics.

The Sanborn's long-nosed bat is adapted for life in arid country, and can be found in desert scrub habitats as well as in high wooded mountains. They depend almost exclusively on caves and abandoned mines and tunnels for daytime roosting sites. Thousands of the bats may roost together at a single site.

At night the bats emerge from roosting sites to feed on nectar and pollen. They prefer large cacti and flowers of paniculate agaves (century plants) which produce showy, easily accessible, night-blooming flowers that are high in protein. The muzzles and tongues of Sanborn's long-nosed bat are highly adapted in both length and surface structure for deep insertion into flowers and collection of pollen particles. When a bat visits a flower, it not only laps up some of the nectar and pollen on the spot, but picks up a considerable amount of pollen on its fur for later consumption. The bats also consume soft and juicy types of fruit. Sanborn's long-nosed bats are easily disturbed and readily take flight when disturbed.

Assessment

The Guatemala MOSCAMED Program is not expected to affect the Sanborn's long-nosed bat because of the bat's daytime roosting behavior and nocturnal activity. The bats would not be exposed to program treatments because they roost in protected areas during the day. Their night blooming food sources would be unaffected by any treatments.

Conclusion

The Guatemala MOSCAMED Program will have no effect on Sanborn's long-nosed bat.

10. Long-tailed river otter *(Lutra longicaudis)*

Note

Six species of neotropical *Lutra* have been recognized, including the river otter *Lutra annectens*. However, in 1972 these species were all combined as one species, *L. longicaudis*. Since then, other changes have been proposed, including combining *L. longicaudis* with *L. canadensis*, with the latter name having priority over the former. Full agreement over this has not been reached, and this assessment will follow the convention of van Zyll de Jong (1972) who changed the name of *L. annectens* to *L. longicaudis*, the species commonly called the long-tailed river otter.

Status

The long-tailed river otter was listed as an endangered species in 35 FR 8495 (June 2, 1970) and 41 FR 24064 (June 14, 1976).

Pertinent Species Information

The long-tailed river otter is found from northwestern Mexico to Uruguay.

The long-tailed river otter's combined head and body length is 460 to 820 millimeters, tail length is 300 to 500 millimeters and weight is 3 to 14 kilograms. The head is flattened and rounded, the neck is short, the trunk is cylindrical, the tail is thick at the base and tapering, the legs are short, and the digits are webbed. The small ears and nostrils can be closed when the animal is in the water.

These otters inhabit inland waterways, as well as estuaries and marine coves. Otters usually venture no more than a few hundred meters from water, and are excellent swimmers and divers. There is usually at least one permanent burrow beside the water with an underwater entrance sloping upward into the bank and into a nest chamber above the high-water level.

The long-tailed river otter preys on fish, frogs, crayfish, crabs, and other aquatic invertebrates. Birds and land mammals, such as rodents and rabbits are also taken. Studies indicate that the fish consumed are mainly nongame species. River otters capture their prey with their mouths, not their hands.

Assessment

The greatest threat to otters is overhunting by man for their valuable fur. The Guatemala MOSCAMED Program's mitigative procedures provide that no aerial applications of malathion bait spray will be made within 200 meters of any recognized body of water. Neither the otter, nor its prey base, will be affected by program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the long-tailed river otter.

11. Brocket deer (*Mazama americana*)

Status

The brocket deer is a species of concern to Guatemala.

Pertinent Species Information

The brocket deer is found from eastern Mexico to northern Argentina.

The combined head and body length of the brocket deer is 0.7 to 1.4 meters and its weight is 8 to 25 kilograms. The body is stout, the limbs are slender, and the back is arched. The hair varies in color from light to dark brown. Although the antlers vary in size, they lack a brow tine and usually consist of simple spikes.

Brocket deer are usually found in woodlands and forests from sea level to elevations of 5,000 meters. They are relatively sedentary, sometimes staying in an area only a few hundred meters in circumference. Diurnal, nocturnal, and crepuscular activity has been reported. These small deer are seldom seen, largely because of their shyness. Their diet includes many kinds of plants, with preferred items being grasses, vines, and tender, green shoots. Brocket deer frequently damage agricultural crops such as beans and corn.

Brocket deer are usually solitary, with the sexes coming together only briefly during courtship. Mating often peaks from July through September and young fawns are observed in the wild usually from February to April. The gestation period is 225 days and a single young is usually produced.

Assessment

Because brocket deer often inhabit land near agricultural areas, these deer may come into contact with Guatemala MOSCAMED Program activities. The brocket deer is not expected to be affected by program treatments, and any effect of program activities probably would be limited to temporary displacement due to human activity. The Guatemala MOSCAMED Program is not expected to affect the brocket deer, its habitat, or its food source.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the brocket deer.

12. Giant anteater (*Myrmecophaga tridactyla*)

Status

The giant anteater is a species of concern to Guatemala.

Pertinent Species Information

There have been no published records of occurrence of the giant anteater in Guatemala since at least 1950, and information published in 1984 indicated the species was extinct in that country. The original range of the giant anteater was throughout Central and South America, from Guatemala to northern Argentina. According to some, giant anteaters have been observed in several different areas of Guatemala. However, those observations have not been documented in the scientific literature. The sightings have probably represented nomadic individuals of the species rather than members of established local populations.

The giant anteater is a relatively large anteater that has a cylindrical snout, diagonal stripe, and bushy tail. The overall length, including tail, is 1.6 to 2.1 meters, and giant anteaters weigh 18 to 39 kilograms. The color of the fur is usually gray with a diagonal stripe that is black with white borders. The powerful claws on the hands and the long, extensible tongue are used to search for food.

The giant anteater is found in swampy areas, humid forests, and savannahs. Adults do not climb trees, but are powerful diggers that rest in secluded spots by curling up, tucking head between forelegs, and covering the head and body with the fan-like tail. They seem to be active during daylight in areas mainly uninhabited by people, and during the night in areas that are more populated. They take to water readily and can swim across wide rivers.

The main food items for giant anteaters are termites and ants whose mounds are easily ripped apart with the giant anteater's claws. The eggs, cocoons, and adult ants are picked up with the sticky, saliva-coated tongue. Beetle larvae are also eaten in the wild. The gestation period for the giant anteater is about 190 days. A single offspring is born, often in the spring, and the mother carries the young on her back until she becomes pregnant again.

Assessment

Although observations of the giant anteater have not been recorded in Guatemala since at least 1950, and the species has been reported to be extinct from Guatemala, some nomadic individuals may exist in Guatemala. Those nomadic individuals are very rare and would not be expected to frequent agricultural areas characterized by much human activity. In addition, the high levels of prey required by the giant anteater are not normally present in association with agricultural areas that will be treated under the Guatemala MOSCAMED Program. The giant anteater, its habitat, and its prey species are not expected to be affected by the Guatemala MOSCAMED Program.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the giant anteater.

13. White-tailed deer (*Odocoileus virginianus*)

Status

The white-tailed deer is a species of concern to Guatemala.

Pertinent Species Information

The white-tailed deer is widely distributed, from southern Canada throughout most of the coterminous United States and Mexico, to Peru and northeastern Brazil.

The combined head and body length of the white-tailed deer is 0.8 to 2.1 meters and its weight is 22 to 215 kilograms, although in Central America the typical weight is often about 40 kilograms. In winter the upper parts are brownish gray and the underparts are lighter. In summer the coat is reddish brown above. Antlers have one main beam with minor branches and attain their full size by the fourth or fifth year of life.

The white-tailed deer forages on grass, weeds, shrubs, twigs, nuts, and lichens. This species also consumes agricultural crops when available.

White-tailed deer can adapt to a great variety of habitats. They prefer areas with enough vegetation for concealment, but usually avoid dense forests. They are often found in dense thickets and mixed growths of small trees and shrubby vegetation wherever the original forest has been cut. These deer walk about cautiously, flee from danger with a series of bounds, and are excellent swimmers. They are generally most active at dawn and at dusk. White-tailed deer often travel in family groups, but not large herds.

In northern parts of their range, white-tailed deer mate from October to January, usually with a peak in November. The gestation period is 195 to 212 days and most births are in April to September.

Assessment

The white-tailed deer's range has extended because of its adaptability and preference for living in association with agriculture and also because of the destruction of its predators.

Because white-tailed deer often inhabit land near agricultural areas, it is possible that these deer will come into contact with Guatemala MOSCAMED Program activities. The white-tailed deer would not be expected to be affected by program treatments and any effect of program activities probably would be limited to temporary displacement due to human activity. The Guatemala MOSCAMED Program is not expected to affect the white-tailed deer, its habitat, or its food source.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the white-tailed deer.

14. Jaguar (*Panthera onca*)

Status

The jaguar, *Panthera onca*, was federally listed as an endangered species in 37 FR 6476 (March 30, 1972).

Pertinent Species Information

In Guatemala, the jaguar is found in remote areas, generally away from human habitation. The jaguar is found from the southern United States to northern Argentina, inhabiting primarily forests and savannahs. At the northern limits of its range, it also inhabits scrub forest and desert. Historic range in the United States has included Texas, New Mexico, and Arizona, although the species is rarely found in those states now.

The jaguar has a combined head and body length ranging from 1,120 to 1,850 millimeters and tail length from 470 to 750 millimeters, with a weight ranging from 36 to 158 kilograms.

The jaguar preys primarily on peccaries and capybaras. Tapirs, crocodilians, and fish are also taken. Most hunting is done on the ground and at night. Prey is stalked or ambushed, and carcasses may be dragged some distance to a sheltered spot. Jaguars climb well and are almost as arboreal as the related African leopard, *P. pardus*. Jaguars require the presence of abundant fresh water, and are excellent swimmers.

There is no specific breeding season throughout most of the jaguar's range, but in the extreme north breeding usually occurs in the spring. The gestation period is from 93 to 105 days with one to four offspring per litter. Newborn offspring remain with their mother about two years and attain full size and sexual maturity at three to four years of age. Individuals have lived up to 22 years in captivity.

Assessment

The jaguar's declined has been attributed to the same factors that affected other large cats—persecution as a predator, habitat loss, and commercial fur hunting. The jaguar has now been exterminated from most of Mexico, much of Central America, and, at the other end of its range, in Uruguay and all but the northmost parts of Argentina.

The Guatemala MOSCAMED Program is not expected to affect the jaguar because the species' remote habitat will not coincide with program treatment areas.

The Guatemala MOSCAMED Program is not expected to affect the jaguar because the remote geographical areas for which it inhabits do not coincide with projected treatment areas. The program is not expected to affect the jaguar, its habitat, or its prey base.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the jaguar.

15. Tamandua (*Tamandua mexicana*)

Status

The tamandua is a species of concern to Guatemala.

Pertinent Species Information

The tamandua, also known as the lesser anteater, is found in southern Mexico to northwestern Venezuela and northwestern Peru west of the Cordillera Oriental.

The tamandua is smaller than the giant anteater, and has an overall length including the tail of 870 to 1440 millimeters and an average weight of 2 to 7 kilograms. The body is covered with short, dense, coarse hair. The snout is elongated, with a mouth opening about the size of a pencil.

Tamanduas inhabit tropical forests and savannahs. These anteaters are thought to live in hollow trees, and spend most of their time in trees. Their movements on the ground are rather clumsy. In the trees, tamanduas move about and feed among the limbs. An individual tamandua might have a period of activity that begins at any time of day or night lasts about 8 hours. During this time, the animals move almost continuously, feeding for less than 1 minute at each ant or termite colony.

The main food items of tamanduas are arboreal (tree-dwelling) ants, tree and ground termites, and bees. Tamanduas concentrate on one type of ant or termite per feeding period, but not the same type of ant or termite from day to day or individual to individual. A single tamandua can eat up to 9,000 ants per day.

The gestation period of the tamandua is 130 to 150 days, with a single young born usually in the spring.

Assessment

The Guatemala MOSCAMED Program is not expected to affect the tamandua because the habitat of the species does not coincide with program treatment areas. Tamanduas generally inhabit forest and savannah areas which are sparsely populated by humans and do not contain Medfly hosts subject to treatment. In addition, the food base of the tamandua—ants and termites—is usually low within agricultural areas because of routine agricultural practices. This would also tend to keep tamanduas at a distance from program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the tamandua.

16. Central American tapir (*Tapirus bairdii*)

Status

The Central American tapir was federally listed as an endangered species in 35 FR 8495 (June 2, 1970).

Pertinent Species Information

The Central American tapir is found from southern Mexico to northern South America. In 1950, the distribution of this species in Guatemala was reported to be restricted to the larger swamps of the Caribbean and Pacific lowlands and of the Peten Region, and to the montane cloud forests of Quiche and Alta Vera Paz.

The Central American tapir is a donkey-sized, short-legged animal. The general body shape—rounded in back and tapered in front—is well suited for rapid movement through thick underbrush. The snout and upper lips are projected into a short, fleshy proboscis. Combined head and body length is 1.8 to almost 2.5 meters and weight is usually 225 to 300 kilograms.

Tapirs may live in nearly any wooded or grassy habitat near a permanent supply of water. They usually shelter in forests and thickets by day and emerge at night to feed in bordering grassy or shrubby areas. Tapirs are agile in closed or open habitat, and in or under water. These animals are generally shy and docile, and seek refuge in water or crash off into the brush when threatened.

Tapirs consume mainly the green shoots of common terrestrial browse plants, as well as the leaves, buds, twigs, and fruits of low-growing terrestrial plants, and may eat some aquatic plants. Foraging is in a zigzag pattern.

Breeding apparently takes place at any time of the year. The gestation period is 390 to 400 days, and the number of offspring is one, or infrequently, two. Young are weaned by the age of one year.

Assessment

The Central American tapir is threatened primarily by forest clearance for agricultural use and excessive hunting. This species is legally protected throughout its range, but the laws are generally poorly enforced.

The Guatemala MOSCAMED Program is not expected to affect the Central American tapir because the habitat of the species does not coincide with program areas. The lowland swamp areas of the coastal lowlands and the Peten, and the cloud forest areas where the tapirs dwell are not subject to program activities. The types of vegetation consumed by tapirs are not Medfly hosts, and therefore would not be treated in the Guatemala MOSCAMED Program. Lastly, because the Central American tapirs have a shy nature they would probably avoid humans and agricultural areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the Central American tapir.

17. West Indian manatee (*Trichechus manatus*)

Status

The West Indian manatee was federally listed as an endangered species in 32 FR 4001 (March 11, 1967) and 35 FR 8495 (June 2, 1970).

Pertinent Species Information

The West Indian manatee occurs in the coastal waters and rivers of the Caribbean and Atlantic Regions of the Americas within tropical and subtropical latitudes. In Guatemala, the West Indian manatee is found in Lake Izabal, the Rio Dulce, along the Caribbean Coast, and also in the Rio Sarstun and other minor tributaries north of Puerto Barrios.

The West Indian manatee is a massive, fusiform, thick-skinned, nearly hairless animal with paddle-like forelimbs, no hindlimbs, and a spatulate, horizontally flattened tail. Adult manatees are 2.8 to 3.5 meters in length and weigh up to 1,590 kilograms.

Manatees usually swim slowly and agilely, but can swim swiftly for short distances. The West Indian manatee spends most of its time either browsing or floating passively just beneath the water surface.

Manatees do not establish territories, but may cover 150 miles of coastline during a summer of browsing. Manatees eat many kinds of plants, preferring submergent plants first, then plants that float on the surface, and finally emergent plants. A mature manatee can eat up to 45.5 kilograms of plant matter each day. Some manatees in coastal areas migrate to warmer waters in the winter, but return to the same sites each summer.

No specific breeding season for the West Indian manatee has been determined, though young are often born in spring and early summer. The gestation period is estimated at 385 to 400 days and parturition is believed to occur in secluded shallows. Usually a single offspring is produced. Individuals are thought to breed every 2 to 5 years, and sexual maturity is reached at 7 to 10 years of age.

Assessment

The decline of manatees in many areas has been attributed to hunting, loss of habitat, and accidents (collisions with boats and boat propellers).

The Guatemala MOSCAMED Program's mitigative procedures provide that no aerial applications of malathion bait spray will be made within 200 meters of any recognized body of water. Although the West Indian manatee lives in the water, its habitat will not be within any treatment area. The manatees themselves, their habitat, and their plant food sources are expected to remain unaffected by Guatemala MOSCAMED Program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the West Indian manatee.

B. Endangered and Threatened Birds of Guatemala

1. White-fronted parrot (*Amazona albifrons*)

Status

The white-fronted parrot is considered a species of concern to Guatemala.

Pertinent Species Information

The white-fronted parrot may be found from Mexico south to Costa Rica. In Guatemala, it is a fairly common resident in the Pacific lowlands and subtropics, the arid interior, and the northern Peten. The species inhabits woodlands and secondary growth in areas from sea level to about 6000 feet in elevation. It apparently is not found in Guatemala's humid Caribbean lowlands.

The white-fronted parrot is a green Amazon parrot with white forecrown and red eye patch. It is a medium-sized bird with wing length of 152-180 millimeters.

This species feeds on figs, Inga seeds, legumes, crotons, corn, mangos, and other crops. White-fronted parrots may congregate in flocks of 30 to 50 birds in the forest treetop canopy or around the edge of cornfields. These parrots often have large communal roosts at sunset. The roosts and flocks persist throughout Guatemala's rainy season, but split up when the parrots scatter into breeding pairs during the dry season. They nest in natural cavities such as knotholes, hollow branches, and palm stubs. The female lays 3 to 5 eggs.

Seasonal movements of white-fronted parrots have been reported in Guatemala. Flocks of up to 20 were seen daily in the foothills of the Sierra de las Minas in eastern Guatemala during July and August, but were not seen during the dry winter months (Forshaw, 1973). The parrots apparently migrate to the arid lower tropical zone in extreme western El Salvador.

Assessment

The Guatemala MOSCAMED Program is not expected to affect the white-fronted parrot. Although the species' food base includes some Medfly host fruits, the species inhabits forests adjacent to the treatment areas only during the wet season and migrates south to nest elsewhere during the dry season. The program suspends chemical treatments during the rainy season, so no exposure from program treatments is anticipated.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the white-fronted parrot.

2. Scarlet macaw (*Ara macao*)

Status

The scarlet macaw is considered a species of concern to Guatemala.

Pertinent Species Information

The scarlet macaw is distributed from Mexico to South America. It was once found in Guatemala's lowlands, but now survives only in the remote areas of the western Peten along the Usamacinta River (Pasquier, 1981). This bird prefers tall and dense deciduous forests and areas along water courses.

The scarlet macaw has bright scarlet plumage with green, blue, and yellow tips on the wings and feathers. This large bird (800-960 millimeters long) has a wing length of 347 to 410 millimeters. Although this brilliant bird is frequently depicted on travel brochures, hunting, trapping, and collecting of nestlings has forced the species to retreat far from settled districts (Forshaw, 1973).

The scarlet macaw feeds on seeds, fruits, nuts, berries, and vegetable matter obtained in the treetops. During the day it feeds or rests in the topmost branches of tall trees.

These birds are generally seen in pairs, family parties or small flocks of up to about 30. Very little is known of their nesting habits. They nest in the winter in the hollows of large trees. The young birds are ready to accompany their parents on daily flights by early February.

Assessment

The Guatemala MOSCAMED Program is not expected to affect the scarlet macaw because the species survives only in remote areas of the Peten Region, where no program activity is projected.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the scarlet macaw.

3. Thick knees (*Burhinus bistriatus*)

Status

The thick knees is considered a species of concern to Guatemala.

Pertinent Species Information

The thick knees is a rare resident of Guatemala, found in the Pacific lowland and the arid interior. The species is fairly numerous in some areas and is distributed from Mexico south through Central America and much of South America. There are several records of thick knees which have strayed into Texas.

The thick knees is a large ploverlike bird which reaches 17 to 20 inches in length. The species exhibits crepuscular and nocturnal behavior. The common name refers to the large "knee" joints which are actually the heels or intertarsal joints. Both sexes have a similar appearance. This species has a buff-colored head with a broad white stripe running over and around the eyes and down the back and sides of the neck. The bill is thick and short, the eyes and eyelids are yellow, and crown is dusky.

The thick knees is found in dry, open country containing scattered brush and trees. Individuals are typically shy, remaining motionless to evade detection, and will fly away swiftly if alarmed in the daytime. It usually feeds at night upon insects, especially grasshoppers, crickets, and beetles. The species also feeds upon worms, mollusks, crustaceans, frogs, lizards, mice and seeds.

Female birds usually lay 2 white- to buff-colored eggs that are heavily spattered with grays or browns (Lack, 1968). The eggs are laid directly on the ground in a shallow unlined depression. Adults are known to move eggs to a new location when threatened. The female incubates the eggs for about 27 days.

Assessment

The Guatemala MOSCAMED Program is not expected to affect the thick knees because the dry savannah habitat of this species does not coincide with program treatment areas. Accordingly, neither the thick knees nor its prey base, including insects, will be affected by the program. The nocturnal habits of the species will further protect it from potential direct contact with program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the thick knees.

4. Imperial woodpecker (*Campephilus imperiales*)

Status

The imperial woodpecker was federally listed as an endangered species in 35 FR 8495 (June 2, 1970).

Pertinent Species Information

The imperial woodpecker is not known to occur in Guatemala. The species formerly occurred throughout the mountains of the Sierra Madre Occidental in the Mexican States of Sonora, Chihuahua, Durango, Zacatecas, Jalisco, and Michoacan (Tanner, 1964).

The imperial woodpecker is the world's largest woodpecker. The male is blue-black with a pointed flaming crest, powerful ivory-colored bill, and large white patch on the wings. The female resembles the male except for her black crest.

The imperial woodpecker's preferred habitat was reported to be mature pine-oak forests. Historic density in suitable forest habitat has been one pair per 25 square kilometers (Tanner, 1964).

Assessment

The last substantiated sighting of an imperial woodpecker occurred in 1958 and the species is believed to be extinct today. There is no evidence that it ever occurred in Guatemala, and apparently it was never abundant anywhere. The U.S. Department of Interior, Fish and Wildlife Service, has confirmed that this species is not known to occur in Guatemala. The closely related pale-billed woodpecker does occur in Guatemala, and in case that may have been the intended species, the pale-billed woodpecker has been assessed separately.

The decline (and possible extinction) of the imperial woodpecker has been attributed to the loss of habitat and hunting of the species. The pines of the Sierra Madre have been continually felled without regard for the preservation of tracts large enough to support the imperial woodpecker. The hunting of this species as logging roads were cleared is believed to be the critical factor in the decline of the species (Tanner, 1964).

The Guatemala MOSCAMED Program is not expected to affect the imperial woodpecker because the species is probably extinct. Moreover, program areas would not have coincided with the species' known historical range or its preferred habitat.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the imperial woodpecker.

5. Pale-billed woodpecker (*Campephilus [melanoleucos] guatemalensis*)

Status

The pale-billed woodpecker is considered a species of concern to Guatemala.

Pertinent species information

The pale-billed woodpecker is fairly common in Guatemala (Land, 1970) and is distributed from Tamaulipas and southern Sonora, Mexico, south to Panama. The species occurs primarily in lowland forests but may be found up to elevations of 6500 feet.

The pale-billed woodpecker is a large bird (205-244 grams) with a wing length 172 to 208 millimeters. Its bill is pale and the head crest is mainly red.

This species feeds primarily on insects found in trees. Larval beetles of the Cerambycidae and Scarabaeidae families comprise a large part of the diet (Short, 1982). Berries are also consumed.

Preferred habitat of the pale-billed woodpecker includes forest edges and humid riverside forests. In some areas it frequents coffee plantations, mixed woods and pastures (Short, 1982).

In Guatemala, breeding occurs in the spring, usually at the start of the rainy season in June and July (Short, 1982). The paired birds tend to remain together throughout the year and range over a large territory. The clutch of eggs is usually two (Janzen, 1983).

Assessment

The pale-billed woodpecker appears to be a fairly common species in the lowlands of Guatemala. This species was analyzed as a precautionary measure in response to public concern about the much rarer but closely related imperial woodpecker. Any concern for the pale-billed woodpecker would probably relate to the preservation of its habitat.

The Guatemala MOSCAMED Program is not expected to affect the pale-billed woodpecker because the species' primary woodland habitat does not coincide with program treatment areas. Although individual birds might forage for beetle larvae beneath the bark of trees in coffee plantations and in treatment areas, those areas would comprise only a small part of each bird's territory.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the pale-billed woodpecker.

6. Common bobwhite (*Colinus virginianus*)

Status

The common bobwhite is considered a species of concern to Guatemala.

Pertinent Species Information

In Guatemala, the common bobwhite is found in open areas of the subtropical, dry forest region adjacent to Chiapas, Mexico (Land, 1970). This zone is transitional between highlands and lowlands and is characterized by open woodlands of oak and pine trees. The common bobwhite can be found in the eastern and central United States, south through Mexico to Guatemala.

The bobwhite is a small, chickenlike bird with a short brown to black bill. Adult bobwhites are 241 to 267 millimeters long with wingspreads of 36 to 41 centimeters. Their life expectancy is 3 to 4 years in the wild, but individuals have survived up to 10 years in captivity.

The bobwhite feeds on seeds of grasses, wild and cultivated legumes, acorns, seeds of pines, sweet gum, ash, grains, and wild fruits (raspberries, blackberries, strawberries, bayberries, wax myrtle, hackberry, grapes, plums, rose hips, dogwood berries, pokeberries, and persimmons). In summer, about 30% of their food consists of invertebrates such as grasshoppers, bugs, flies, and spiders (Johnsgard, 1973).

Immatures are gregarious most of their first year of life. Families with young join together in coveys of up to 30 birds in late summer and early fall. At roosting time, they form groups of about 10 to 15 birds in a circle with heads pointing outward, tails pointed skyward, and bodies packed close together to conserve body heat. Roosting circles also facilitate general alarm and quick evasive behavior in response to danger. In April or May, the coveys begin to break up into mating pairs. The pairs may mate again in progressive seasons if both members continue to live.

Bobwhites nest on the ground along weed-grown fence rows, brushy corners of old fields, in woods under brush piles, at edges of woods, thickets, swamps, orchards, and fields. If the first nest is destroyed, a pair may build a second, third, or even fourth nest until their brood is raised. Each female usually lays 14 to 16 white or cream-white eggs.

Assessment

The Guatemala MOSCAMED Program is not expected to affect the common bobwhite because the subtropical dry forest habitat of this species (in the Medfly-free zone) does not coincide with program treatment areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the common bobwhite.

7. Golden-cheeked wood warbler (*Dendroica chrysoparia*)

Status

The golden-cheeked wood warbler was federally listed as an endangered species in 50 FR 18844 (May 4, 1990).

Pertinent Species Information

The golden-cheeked wood warbler overwinters from eastern Guatemala to Nicaragua, arriving as early as August 27 (Land, 1970). It overwinters in undisturbed pine and oak woodlands at elevations of 1750 to 2550 meters. The golden-cheeked wood warbler has long been rare over its general range, but was once common in its limited nesting range in Texas.

The golden-cheeked wood warbler is 4-1/2 to 5 inches long. The breeding plumage of the male is deep black from crown to tail with golden cheeks and a black eye streak. The female's plumage is similar except for streaked rather than solid black feathers, a white throat, and a dark green back.

This warbler feeds almost exclusively on insects, but no detailed studies have been done of its feeding habits (Terres, 1980). The female is shy and seldom seen while nesting, but the male is conspicuous, very actively flying from tree to tree when feeding on clear days from dawn to dusk. Mean life expectancy is probably about 4 years in the wild.

The nests are usually placed in the upright forks of older, mature Ashe cedars, 6 to 20 feet above ground. The nesting range is limited to a small area of dry upper slopes and ridges in the Edwards Plateau of southcentral Texas. The female lays 3 to 5 white or cream-white eggs, speckled with browns and grays between April and June. The incubation period is unknown.

Assessment

The decline of this species has been attributed to habitat destruction and cowbird parasitism. It is particularly threatened by brush removal and cutting of old cedars to create grassland for grazing. The loss of the species' habitat from clearing of the Ashe juniper/scrub oak forests for urban development is also eliminating primary nesting areas in Texas.

The Guatemala MOSCAMED Program is not expected to affect the golden-cheeked wood warbler because the species' habitat (the undisturbed pine and oak forests) does not coincide with program treatment areas. This warbler obtains all its food from these forests and is not likely to transit Medfly treatment areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the golden-cheeked wood warbler.

8. Keel-billed motmot (*Electron carinatum*)

Status

The keel-billed motmot is listed as a threatened species by the International Council for Bird Preservation (Collar and Andrew, 1988).

Pertinent Species Information

The keel-billed motmot ranges from southern Mexico to Costa Rica. It is very rare in Guatemala with only two site records. These records were of occurrences in the Peten and some northern sections of the humid tropical forests of the Caribbean lowlands.

This species is medium sized, with a wing length of 111-121 millimeters. It has a dull green color and a long, black and white tail.

Little is known of the biology, habits, or life cycle of the keel-billed motmot.

Assessment

The Guatemala MOSCAMED Program is not expected to affect the keel-billed motmot because the species' remote habitat in the northern humid tropical forests does not coincide with projected program areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the keel-billed motmot.

9. Orange-breasted falcon (*Falco deiroleucus*)

Status

The orange-breasted falcon is listed as a threatened species by the International Council for Bird Preservation (Collar and Andrew, 1988).

Pertinent Species Information

The orange-breasted falcon is found from Mexico to South America. In Guatemala, it is found primarily in the Peten Region, extending south to Honduras in the lowlands along the Caribbean Sea. The species is a resident of forest and forest edges in the lowlands to an elevation of 7500 feet. It is uncommon to rare throughout its range. It is known to perch on top of tall dead trees and tall buildings.

The orange-breasted falcon is a medium-sized falcon with wing length of 248-287 millimeters. It resembles a small peregrine in its habits and looks like one in flight (Brown and Amadon, 1968).

The prey of this species is chiefly or entirely birds. Doves, caciques, and parrots are often caught.

This species has been observed nesting in holes in the Maya ruins at Tikal (Smithe, 1966). It is also said to nest in church towers and belfries. One clutch of three eggs was found at the base of a palm frond in a stick-filled depression. Eggs are buff-colored with dark red-brown freckling.

Assessment

The orange-breasted falcon is not expected to be affected by the Guatemala MOSCAMED Program because of its rarity and its preferred habitat (forests and forest edges) which does not coincide with program treatment areas. Thus, neither the orange-breasted falcon nor its prey base will be affected by program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the orange-breasted falcon.

10. Northern aplomado falcon (*Falco femoralis septentrionalis*)

Status

The northern aplomado falcon was federally listed as an endangered species in 51 FR 6690 (February 25, 1986).

Pertinent Species Information

The northern aplomado falcon was once distributed from southwestern United States to Guatemala. It is now very rare or extirpated from Guatemala. There are no records of its occurrence in Guatemala in this century (Land, 1970).

Aplomado falcons are medium sized, gray falcons. They prefer rather open savannah or semi-arid plains. Aplomado falcons prey on other birds, including doves and quail, but may also take lizards and mice.

Typically, aplomado falcons nest in platforms of twigs made in low trees. Eggs usually number three and are oval and whitish.

Assessment

The reasons for the decline of the aplomado falcon are not certain, but deterioration of habitat from agricultural exploitation (especially livestock production) has been suspected. In Mexico and Central America, DDT has been implicated in eggshell thinning.

The Guatemala MOSCAMED Program is not expected to affect the northern aplomado falcon because the subspecies is extremely rare or extirpated from Guatemala. Even if migrants were to visit Guatemala, their preference for open savannah and semi-arid plains would make it highly unlikely that they would come into contact with any program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the northern aplomado falcon.

11. American peregrine falcon (*Falco peregrinus anatum*)

Status

The American peregrine falcon was federally listed as an endangered species in 35 FR 16047 (October 13, 1970), 35 FR 8495 (June 2, 1970), and 49 FR 10526 (March 20, 1984).

Pertinent Species Information

Peregrine falcons (both American peregrine falcons and Arctic peregrine falcons) are transient and winter visitors in Guatemala on their migratory flights north or south. They are primarily coastal migrants in Central America (Land, 1970). Migration occurs throughout their recorded range of Alaska to South America, and wintering sites have been reported in areas as far north as Colorado and Utah.

The American peregrine falcon is a medium- to large-sized falcon. Its mean life expectancy is probably near 4 years in the wild, whereas some have reached 20 years in captivity.

Peregrine falcon habitat is considered to consist of hunting sites, nesting sites, and wintering and migration areas. Peregrines prey almost exclusively on smaller birds such as blackbirds, doves, songbirds, jays, and shorebirds. Prey is normally taken on the wing, and falcons may exceed 60 mph in flight when overtaking their quarry. Prey abundance is usually a factor in eyrie selection and sites are almost always close to water. Peregrines may travel up to 17 miles from eyries to hunt. Preferred hunting areas are areas that usually contain an abundance of bird life. These include cropland, meadows, river bottoms, marshes, and lakes.

Nesting occurs from central Mexico north to central Alaska. Peregrines generally nest in mountainous areas on cliffs ranging from low elevations to above 9,000 feet. There are records of peregrines nesting on low dikes in Utah marshes, mud banks, and large trees along rivers of the Great Plains. Peregrines in the Rocky Mountains and southwestern United States nest primarily on mountain cliffs and river gorges. In northern latitudes eyries may be found on open ledges or potholes.

Female peregrines do not normally breed until at least 2 years of age and pairs are usually present in the eyries by mid-March. Eyries are generally constructed on cliff outcroppings, away from human disturbance, and rarely are found on trees or mudbanks. In the northern part of their range, a clutch of 3 to 4 eggs is laid by late April. The incubation period lasts 33 days and the young remain with their parents, who feed and defend them for several weeks following fledging in mid-June to mid-July.

Assessment

The decline of the American peregrine falcon has been linked to reproductive failure caused by chlorinated hydrocarbon pesticides, particularly DDT. Reproductive failure includes both eggshell thinning and abnormal parental behavior (USFWS, 1982, 1984a, 1987). Eggshell thinning has not been linked to any of the treatment materials used in the Guatemala MOSCAMED Program.

The Guatemala MOSCAMED Program is not expected to affect the American peregrine falcon during its seasonal migration through coastal areas of Guatemala. Neither the American peregrine falcon nor its prey base would be affected by the program.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the American peregrine falcon.

12. Arctic peregrine falcon (*Falco peregrinus tundrius*)

Status

The Arctic peregrine falcon was federally listed as a threatened species in 35 FR 16047 (October 13, 1970), 35 FR 8495 (June 2, 1970), and 49 FR 10526 (March 20, 1984).

Pertinent Species Information

Peregrine falcons (both American peregrine falcons and Arctic peregrine falcons) are transient and winter visitors in Guatemala on their migratory flights north or south. They are primarily coastal migrants in Central America (Land, 1970). Migration occurs throughout their recorded range of Alaska to South America, and wintering sites have been reported in areas as far north as Colorado and Utah.

The American peregrine falcon is a medium- to large-sized falcon. Its mean life expectancy is probably near 4 years in the wild, whereas some have reached 20 years in captivity.

Peregrine falcon habitat is considered to consist of hunting sites, nesting sites, and wintering and migration areas. Peregrines prey almost exclusively on smaller birds such as blackbirds, doves, songbirds, jays, and shorebirds. Prey is normally taken on the wing, and falcons may exceed 60 mph in flight when overtaking their quarry. Prey abundance is usually a factor in eyrie selection and sites are almost always close to water. Peregrines may travel up to 17 miles from eyries to hunt. Preferred hunting areas are areas that usually contain an abundance of bird life. These include cropland, meadows, river bottoms, marshes, and lakes.

Nesting occurs from central Mexico north to central Alaska. Peregrines generally nest in mountainous areas on cliffs ranging from low elevations to above 9,000 feet. There are records of peregrines nesting on low dikes in Utah marshes, mud banks, and large trees along rivers of the Great Plains. Peregrines in the Rocky Mountains and southwestern United States nest primarily on mountain cliffs and river gorges. In northern latitudes eyries may be found on open ledges or potholes.

Female peregrines do not normally breed until at least 2 years of age and pairs are usually present in the eyries by mid-March. Eyries are generally constructed on cliff outcroppings, away from human disturbance, and rarely are found on trees or mudbanks. In the northern part of their range, a clutch of 3 to 4 eggs is laid by late April. The incubation period lasts 33 days and the young remain with their parents, who feed and defend them for several weeks following fledging in mid-June to mid-July.

Assessment

The decline of the Arctic peregrine falcon has been linked to reproductive failure caused by chlorinated hydrocarbon pesticides, particularly DDT. Reproductive failure includes both eggshell thinning and abnormal parental behavior (USFWS, 1982, 1984a, 1987). Eggshell thinning has not been linked to any of the treatment materials used in the Guatemala MOSCAMED Program.

The Guatemala MOSCAMED Program is not expected to affect the Arctic peregrine falcon during its seasonal migration through coastal areas of Guatemala. Neither the Arctic peregrine falcon nor its prey base would be affected by the program.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the Arctic peregrine falcon.

13. Whooping crane (*Grus americana*)

Status

The whooping crane was federally listed as an endangered species in 32 FR 4001 (March 11, 1967) and 35 FR 8495 (June 2, 1970).

Pertinent Species Information

The whooping crane is one of the rarest birds in North America. Although the species was named as a species of concern to Guatemala, central Mexico has been the limit of its southern range for at least the last 300 years (Allen, 1952). Whether the range ever extended to Guatemala or any strays ever flew there is uncertain. The U.S. Department of Interior, Fish and Wildlife Service, has confirmed that this species is not known to occur in Guatemala.

The whooping crane is one of the tallest of North American birds, at almost 1.5 meters in height. Adult plumage is snowy-white with black primary feathers, and a red crown.

Like many other wading birds, it subsists on a diet of crabs, clams, frogs, or fish, depending upon seasonal availability. Whooping crane habitat includes marshes, river bottoms, potholes, prairies, and occasionally, cropland. Nesting usually occurs in potholes among bulrush (*Scirpus validus*), cattail (*Typha* sp.), sedge (*Carex aquatilus*), and other plant species. Whooping cranes generally mate for life. Delayed sexual maturity may prevent breeding until cranes are 4 to 6 years old. One to three eggs are produced in late April or early May.

The wild breeding population of whooping cranes migrates annually between breeding grounds at Wood Buffalo National Park, Northwest Territories, Canada, and the primary wintering areas at Aransas National Wildlife Refuge and Matagorda Island, Texas. Infrequently, a few cranes may spend the summer in the Aransas area, and vagrants have been observed occasionally in northern Mexico, especially in Tamaulipas.

Assessment

Several factors are believed to have contributed to the decline of the whooping crane: the crane's biological characteristics (ancestral breeding grounds and delayed sexual reproduction), adverse weather in the habitat (late snow or drought), human disturbance, and habitat modification.

The Guatemala MOSCAMED Program is not expected to affect the whooping crane because the species is not likely to migrate as far as Guatemala. Even if an occasional individual did reach Guatemala, its preferred aquatic and estuarine habitat would not be expected to coincide with treatment areas and would be excluded from program treatments due to the special protection afforded bodies of water.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the whooping crane.

14. Harpy eagle (*Harpia harpyja*)

Status

The harpy eagle was federally listed as an endangered species in 41 FR 24064 (June 14, 1976).

Pertinent Species Information

The harpy eagle ranges from South-eastern Mexico to Paraguay and Argentina, and is found in largely undisturbed lowland tropical forests (King, 1981; Brown and Amadon, 1968). Occasionally, it can be found in subtropical forests up to 6500 feet elevation (Wetmore, 1972). Few areas of lowland forest are of sufficient size to sustain viable populations except in the Amazon region and some larger natural reserves or parks.

The harpy eagle is a very large bird; adults weigh 4-8 kilograms and have a wing length of 543-610 millimeters. The head has a prominent, double-pointed crest and the tail is long. It is physically the most formidable eagle in the world in strength, ferocity, and rapacity (Brown and Amadon, 1968).

The harpy eagle preys on howler monkeys, sloths, other cebid monkeys, opossums, coatis, kinkajous, and porcupines (Izor, 1985; Brown and Amadon, 1968). Although most of its prey consists of arboreal mammals, it also takes agouti. There is a behavioral aversion to non-mammalian prey, even in captivity (Foerster, 1972). This species is also the only known avian predator of man (Izor, 1985).

Harpy eagles nest approximately 110 to 190 feet above the ground in the forks of tall trees of forests (Wetmore, 1972; Brown and Amadon, 1968). Nests are bulky structures of 1.2 to 1.3 meters in diameter. The female lays 1 to 2 dull white eggs. The harpy eagle does not nest more frequently than every other year (Brown and Amadon, 1968).

Assessment

The distribution of the harpy eagle has been diminished by the activities of man. Forest destruction has caused significant reduction of its range (King, 1981). Hunters have relentlessly shot the eagle as well as the prey species on which it depends for survival. It is a prime indicator species of largely undisturbed tropical lowland forest.

The harpy eagle is not expected to be affected by the Guatemala MOSCAMED Program because the undisturbed tropical lowland forest habitat of this species will not be treated. There are no Medfly hosts in these forested areas, so no program activity will occur there.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the harpy eagle.

15. Social eagle (*Harpyhaliaetus gregarius*)

Status

The social eagle, *Harpyhaliaetus gregarius*, was identified as a species of concern to Guatemala in a list provided to the Fish and Wildlife Service by the International Union on the Conservation of Nature and Natural Resources (IUCN).

Pertinent Species Information

Neither the Animal and Plant Health Inspection Service nor the Fish and Wildlife Service have found any information on the species or have evidence that such a species ever existed. The species may be fictional or synonymous with a species better known under another name.

Assessment

An assessment is not possible for this species.

Conclusion

There is no evidence that this species ever existed in Guatemala or anywhere else. Accordingly, the Guatemala MOSCAMED Program will have no effect on the species.

16. Solitary eagle (*Harpyhaliaetus solitarius*)

Status

The solitary eagle is considered a species of concern to Guatemala.

Pertinent Species Information

The solitary eagle is distributed from Mexico to South America. The natives in Sonora, Mexico consider this species to be very rare. The only recorded find in Guatemala was a specimen taken in the 19th century near San Jeronimo. The species may still occur in some secluded areas of Guatemala.

The solitary eagle is a plain slate-grey bird with a slight bushy crest on the nape. Adults are large (660-710 millimeters) with a wing length of 485 to 525 millimeters.

Little is known of the general habits and feeding behavior of the solitary eagle. The nesting birds are frequently seen carrying snakes (Brown and Amadon, 1968). The remains of a chachalaca was found at one nest and a pair of solitary eagles were reported to have harried fawns. A solitary eagle's nest observed in Sonora, Mexico was 80 feet high in a Mexican yellow pine, lined with green leaves, and about 4 feet in diameter. A single white, rough-textured egg was found on May 9. Apparently females lay only a single egg.

Assessment

The Guatemala MOSCAMED Program is not expected to affect the solitary eagle because program areas will not coincide with the remote and secluded habitat of this species. Neither the eagle nor its prey base would be expected to come into contact with program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the solitary eagle.

17. Ocellated turkey (*Meleagris ocellata*)

Status

The ocellated turkey is listed as a threatened species by the International Council for Bird Preservation (Collar and Andrew, 1988).

Pertinent Species Information

The ocellated turkey is found in the northern Peten of Guatemala, in Belize, and within the Yucatan Peninsula of Mexico.

The ocellated turkey resembles a domestic turkey. The male has a blue head with red warts and "eyed" tailfeathers. The female is more subdued in coloring and lacks warts.

This species inhabits woodlands, woodland edges, and cornfields. Its habits are similar to those of the wild turkeys of North America. They feed mainly on the ground, but roost primarily in the trees.

Assessment

The Guatemala MOSCAMED Program is not expected to affect the ocellated turkey because the habitat of this species in the northern Peten does not coincide with program areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the ocellated turkey.

18. Crested eagle (*Morphnus guianensis*)

Status

The crested eagle is listed as a threatened species by the International Council for Bird Preservation (Collar and Andrew, 1988).

Pertinent Species Information

The crested eagle is a large eagle (103-118 millimeters) with a wing length of 425 to 481 millimeters. The crown is grayish black, the mantle is black, and the tail is black with mottled grey and white bands.

The crested eagle inhabits only the most impenetrable forests in the warmest and most humid coastal regions, particularly at the edges of rivers. It frequently alights on the tops of the highest trees.

Little is known of the habits of this species. It feeds on small monkeys, opossums, birds, and reptiles. The crested eagle builds an enormous nest in the tallest jungle trees (Brown and Amadon, 1968). The eggs are cream-colored with large pale yellow-brown spots at the broad end and finer spots over the rest of the surface.

Assessment

The Guatemala MOSCAMED Program will not affect the crested eagle because program areas will not coincide with the dense forest habitat of this species. Neither the species nor its prey base are expected to come into contact with any program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the crested eagle.

19. Wood stork (*Mycteria americana*)

Status

The wood stork was federally listed as an endangered species only in the United States in 49 FR 7335 (February 28, 1984).

Pertinent Species Information

The wood stork is found primarily in coastal areas of Guatemala, particularly near Belize and the Yucatan (Peterson and Chalif, 1973). The species ranges from the United States south to Argentina, Cuba, and Hispaniola. The United States breeding populations are presently restricted to Florida, Georgia, and a small part of South Carolina. The U.S. Department of Interior, Fish and Wildlife Service, has reported that individuals from this species' endangered population in the United States do not migrate to Central America.

The wood stork is a large, long-legged wading bird with a white body, a gray naked head, and a thick, dark bill.

Wood storks prefer fresh water, brackish wetlands, and cypress and mangrove swamps. Depressions in these marshes, where fish become concentrated in dry periods, are preferred feeding areas. Wood storks require a high concentration of prey—small fish, topminnows, and sunfish. A stork probes the water with its beak partially open and, if a fish touches it, the bill reflexively snaps shut. This method of feeding is called tacto-location (USFWS, 1986).

Wood storks live in colonies often consisting of 5 to 25 platform nests per tree. They lay 2 to 5 eggs and fledge 2 young in a good year (Ehrlich et al., 1988). Individuals often range as far as 80 miles from nesting to feeding areas (USFWS, 1986).

Assessment

In south Florida, decline of the wood stork has been linked to reproductive failures from feeding problems caused by water management areas. Water levels in the swamps remain too high for the stork to feed properly. Nest failures have even been reported in protected areas such as the Everglades (USFWS, 1986).

The wood stork is not expected to be affected by the Guatemala MOSCAMED Program because this species' habitat is not subject to treatment. In addition, aerial applications of malathion bait spray are precluded within 200 meters of any recognized body of water. Potential for runoff of pesticide is averted by suspension of treatments during the rainy season. As a result, neither the wood stork nor its prey base will be affected by program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the wood stork.

20. Eskimo curlew (*Numenius borealis*)

Status

The Eskimo curlew was federally listed as an endangered species in 32 FR 4001 (March 11, 1967) and 35 FR 8495 (June 2, 1970).

Pertinent Species Information

The Eskimo curlew may be a seasonal migrant in Guatemala. The species is distributed from the Great Plains in the United States to the pampas of Argentina. Some individuals were known to fly south over the Great Plains to the Texas coast (World Wildlife Fund, 1990), and some were recorded to have flown nonstop over Mexico (Peterson and Chalif, 1973). Recent sightings were made in Texas in May 1981 and April 1987 and in Nebraska in April 1987. In the past, Eskimo curlews migrated late in the summers to overwintering sites on the pampas of Argentina by flying over open ocean.

The Eskimo curlew, also known as the prairie pigeon and the doughbird, is an upland shore bird. A wading bird, the Eskimo curlew is the smallest of the American curlews, reaching only about 14 inches in length. Plumage is very similar in both sexes, typically dark brown above and lighter below.

The Eskimo curlew feeds on grasshoppers and their eggs, grubs and cutworms in plowed fields, berries, and small snails (Terres, 1980). This species normally nests in wetlands north of the tree line in open tundra and in tidal marshes. It formerly nested further north than any other American curlew, in the treeless tundra near the shores of the Arctic.

Assessment

Until recently, the Eskimo curlew was considered extinct. The species was once so numerous that a single flock in Nebraska covered 40 to 50 acres (Terres, 1980). Breeding populations were estimated recently to number from 100 to 150 birds (World Wildlife Fund, 1990).

The species' decline is believed to be linked to hunting during migration, disease, and predation. Recommendations of the American Ornithologists' Union include protection and management of the species stopover areas along migration routes.

The Guatemala MOSCAMED Program is not expected to affect the Eskimo curlew because this species migrates over Guatemala with only brief stopovers in aquatic or shore habitats. Those habitats will not be treated because they do not contain Medfly hosts and also are subject to program restrictions relative to protection of water bodies.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the Eskimo curlew.

21. Horned guan (*Oreophasis derbianus*)

Status

The horned guan was federally listed as an endangered species in 35 FR 8495 (June 2, 1970).

Pertinent Species Information

The horned guan is found in remote, inaccessible areas of northwestern Guatemala and Chiapas, Mexico. It inhabits humid evergreen broadleaf forests at elevations of 7000 feet or more (Davis, 1972). These locations are in upper cloud forests of some volcanic slopes.

The horned guan has a fowl-like appearance with a bill like a chicken's, and is the size of a turkey. The species has an erect-red "horn", white breast and tailbands, and bright red feet.

The horned guan is primarily terrestrial, but will feed and roost in trees.

Assessment

Like other members of the Cracidae family, the horned guan is hunted for food by the natives, and has become rare as a result.

The Guatemala MOSCAMED Program will not affect the horned guan because the guan's remote habitat (upper cloud forests on volcanic slopes of northwestern Guatemala) does not coincide with program treatment areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the horned guan.

22. Brown pelican (*Pelecanus occidentalis*)

Status

The brown pelican was federally listed as an endangered species in 35 FR 16047 (October 13, 1970), in 35 FR 8495 (June 2, 1970), and in 50 FR 4945 (February 4, 1985).

Pertinent Species Information

The brown pelican is listed as endangered in the States of Texas, Louisiana, and California. The brown pelican is fairly common on both coasts of Guatemala, less common in the Peten (Land, 1970).

The brown pelican is a dark brown water bird with white bands around the head and neck, and a distinctive bill and throat pouch. Immature birds have a dark head and a white underside. Adults weigh up to 3.6 kilograms and may have a wingspan of 2.1 meters (Peterson, 1980).

The habitat needs of the brown pelican are predator-free nesting areas, adequate offshore food supply, and roosting sites. The quality of the offshore sites is important to breeding success. Offshore rocks and islands, pilings, and jetties near nesting sites are important roosting areas (USFWS, 1983). Pelicans are colonial and nest on small coastal islands in mangrove trees or on the ground, in the absence of potential predators. Nests are built of sticks, reeds and grasses. Pelicans lay 3 eggs, and the altricial young are fledged at 11 to 13 weeks of age (USFWS, 1979). The pelican feeds on fish catches by diving and may rely on anchovies during the breeding season (Ehrlich et al., 1988).

Assessment

The decline of the brown pelican population in California was precipitated by a near total reproductive failure in the 1950's and 1960's as eggshells became increasingly thin and susceptible to breakage. High concentrations of the pesticide DDT have been implicated in eggshell thinning (USFWS, 1983). Eggshell thinning has not been linked to any of the treatment materials used in the Guatemala MOSCAMED Program.

Brown pelican population declines in the southeastern United States have been linked to weather conditions, predation, starvation, and vandalism (USFWS, 1979).

The brown pelican will not be affected by the Guatemala MOSCAMED Program because its aquatic and nesting habitats are not subject to treatment and aerial applications of malathion bait spray are precluded within 200 meters of any recognized body of water. Potential for runoff of pesticide is averted by suspension of treatments during the rainy season. As a result, neither the brown pelican nor its prey base will be affected by program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the brown pelican.

23. Black chachalaca or highland guan (*Penelopina nigra*)

Status

The black chachalaca is listed as a threatened species by the International Council for Bird Preservation (Collar and Andrew, 1988).

Pertinent Species Information

In Guatemala, the black chachalaca is found in the rich, secluded forests of the subtropical highlands and in the cloud forests. The brushy oak-pine woodlands and undisturbed cloud forests are prime habitat (Land, 1970). The species is shy amd spends much time well hidden on the ground.

The black chachalaca is fowl-like in appearance with a bill like a chicken's. Males are glossy black with a long tail, bright red dewlap, and scarlet legs. Females are brown, with heavily barred wings, bare red throat, and scarlet legs.

Assessment

This species' decline has been attributed to hunting and disturbance of its secluded forest habitat.

The Guatemala MOSCAMED Program will not affect the black chachalaca because the species' habitat (remote forest areas) does not coincide with program areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the black chachalaca.

24. Resplendent quetzal (*Pharomachrus mocinno*)

Status

The resplendent quetzal was federally listed as an endangered species in 41 FR 24064 (June 14, 1976).

Pertinent Species Information

The resplendent quetzal is found in cloud forests from Oaxaca and southwestern Chiapas in Mexico to western Panama.

The resplendent quetzal is a large bird (210 grams) with a wing length of 185 to 218 millimeters. The male is considered extremely beautiful, with a metallic to golden green upper breast and extensive tail plumes. The female is more subdued in coloring and has a much shorter tail plume.

The resplendant quetzal's preferred habitat consists of virgin cloud forests composed of crowded, lofty trees forming a canopy 100 to 150 feet high (Davis, 1972; Skutch, 1983). The quetzal's food includes fruits of the laurel family, particularly relatives of avocados and nectarines. The usual diet consists of fruit, land snails, lizards, frogs, and large insects.

Breeding occurs from early April to August. The nest consists of an old woodpecker hole or excavation in some decaying wood. The female usually lays 2 light blue eggs on the floor of the unlined nest. The nest is from 4 to 27 meters high and may be re-used for a second brood if both parents survive for another year. Both male and female incubate the eggs for 17 to 18 days until they hatch.

Assessment

Although still common in remote areas of Central America, this species has declined seriously throughout its range as a result of the extensive destruction of its cloud forest habitat. In addition, because the brilliantly plumed birds have been hunted for local use or trade and sought by museums, their numbers have decreased significantly.

The Guatemala MOSCAMED Program is not expected to affect the resplendant quetzal because the species' remote habitat (virgin cloud forests) does not coincide with program areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the resplendent quetzal.

25. Atitlan grebe (*Podilymbus gigas*)

Status

The Atitlan grebe was federally listed as an endangered species in 35 FR 8495 (June 2, 1970).

Pertinent Species Information

The only known populations of the Atitlan grebe have been found in localized areas along the shores of Lake Atitlan, Guatemala. Recent surveys have not confirmed the existence of any individuals of the species. The International Union for Conservation of Nature and Natural Resources considers this species extinct.

The Atitlan grebe resembles the pied-billed grebe, except for its larger size, inability to fly, and contrasting color bands.

The Atitlan grebe usually stays well away from shore, frequenting reed beds that grow in relatively deep water. Reed beds of rush or reed (*Scirpus*) and cattail (*Typha*) are the primary habitat of the grebe and provide both cover and nesting sites. The Atitlan grebe preys on marine life, especially crabs. Its powerful bill, massive head, neck and jaw musculature are probably evolutionary adaptations that enable it to feed on crabs.

Assessment

The decline of the Atitlan grebe has been linked to two factors: harvesting of the rushes and cattails of its habitat by Indians for a local weaving industry (King, 1981), and competition for its food by non-native bass. As a consequence, Atitlan grebe populations have decreased sharply along the quarter of Lake Atitlan that constituted the remaining nesting habitat of the species.

Should the Atitlan grebe still survive in the vicinity of Lake Atitlan, there would be no effect on the species due to the Guatemala MOSCAMED Program. Lake Atitlan and its surrounding area will not be subject to program treatments because: (1) the program does not apply pesticides over bodies of water, (2) there are no Medfly host that harbor the pest in the area, and (3) Lake Atitlan and its surrounding area have been identified as a valuable natural resource and have been afforded protection from program treatments.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the Atitlan grebe.

26. Least tern (*Sterna antillarum*)

Status

The interior population of the least tern was federally listed as endangered only in the United States in 50 FR 21792 (May 28, 1985).

Pertinent Species Information

In Guatemala, the least tern is a transient species that has been seen in August and September on both coasts. This species overwinters in South America and has been recorded to breed in Belize (Land, 1970). The least tern exhibits a localized pattern of distribution, and migrates annually. It breeds regularly in western North Dakota and central South Dakota.

This waterbird is one of the smaller terns and has predominantly white plumage. The back upper surface of the wings are gray, and the cape and outer primaries are black.

The least tern is highly adaptable to life on the wing and generally forages while in flight, snatching fish, crustaceans, and insects from the surface of the water.

The least tern's breeding habitat is characterized by bare or nearly bare alluvial islands or sandbars, favorable water levels during the nesting season, and availability of food (50 FR 21784-21792, May 28, 1985). Nesting colonies occupy sandy sites that are relatively free of vegetation. One to three (usually two) eggs are laid in shallow scrapes. Nesting occurs from early May into August.

Assessment

A principal factor in the decline of the interior least tern has been the loss of suitable habitat. Channelization projects and flood control dams throughout its historic range have prevented the natural creation and continuance of islands and sandbars it prefers. Other factors contributing to the least tern's decline include fluctuations in water levels, extreme summer temperatures, and predation by rats, coyotes, cats, and predator birds (Whitman, 1988).

The Guatemala MOSCAMED Program is not expected to affect the least tern because the habitat of this species does not coincide with program areas. The coastal areas and sandbars frequented by the tern in its migrations would not be subject to program activities because they do not contain Medfly host species or would be excluded from program treatments due to the special protection afforded bodies of water.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the least tern.

27. Roseate tern (*Sterna dougallii dougallii*)

Status

The roseate tern was federally listed as an endangered species in 52 FR 42068 (November 2, 1987).

Pertinent Species Information

The roseate tern is a rare subspecies which most experts believe to be rapidly declining. Its distribution is spotty and not much is known about its occurrence in Guatemala. The majority of the population occurs in Puerto Rico and the U.S. Virgin Islands. The subspecies is believed to have disappeared as a breeder from Belize and St. Croix in this century. If the roseate tern occurs at all in Guatemala, it is probably as a rare seasonal migrant.

Roseate terns are waterbirds, nesting on beach areas or sandbars. Most roseate terns winter near the continental shores of northern South America, from Trinidad eastward to Bahia, Brazil. In the Caribbean, roseate terns nest between May and July.

Assessment

The decline of the roseate tern has been linked to four factors: egg collecting, human disturbance (tourists), predation by rats, and netting (principally on the coast of Guyana).

The Guatemala MOSCAMED Program is not expected to affect the roseate tern because the habitat of this subspecies does not coincide with program areas. The coastal areas and sandbars which might be frequented by rare seasonal migrants would not be subject to program activities because they do not contain Medfly host species or would be excluded from program treatments due to the special protection afforded bodies of water.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the roseate tern.

28. Azure-rumped tanager (*Tangara cabanisi*)

Status

The azure-rumped tanager is listed as a threatened species by the International Council for Bird Preservation (Collar and Andrew, 1988).

Pertinent Species Informatio

The azure-rumped tanager is a small green and blue bird with a whitish abdomen. It is an extremely rare species, with only two specimens known to science (King, 1971). The two specimens are from southern Chiapas, Mexico, and the highlands of western Guatemala. The cloud forests of the Sierra Madre are the apparent habitat for this species.

The reasons for the rarity of this species are unknown. Much of this forest area has been cleared for coffee plantations and cattle grazing. The unique habitat of this species is now scarce and found only in patches on the higher ridges.

Assessment

The Guatemala MOSCAMED Program is not expected to affect the azure-rumped tanager because the species' habitat (in remote cloud forest areas) does not coincide with program areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the azure-rumped tanager.

29. Belted flycatcher (*Xenotriccus calizonus*)

Status

The belted flycatcher is considered a species of concern to Guatemala.

Pertinent Species Information

The belted flycatcher is a rare species, occurring in Guatemala and Chiapas, Mexico. In Guatemala, it has been recorded only at Lake Atitlan and in Baja Verapaz. It inhabits brushy hillsides, generally from about 5,000 to 6,000 feet in elevation, usually not far from water.

The belted flycatcher is fairly small, with an olive brown back, dark brown crown, and grayish olive face with white eye ring.

Assessment

The belted flycatcher is very rare in Guatemala, limited to the areas of Lake Atitlan and Baja Verapaz. The belted flycatcher is not expected to be affected by the Guatemala MOSCAMED Program because its only known habitats in Guatemala are in areas which do not coincide with program treatment areas.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the belted flycatcher.

C. Endangered and Threatened Reptiles of Guatemala

1. Alligator (*Alligator* spp.)

Status

The alligator is a species of concern to Guatemala.

Pertinent Species Information

The U.S. Department of Interior, Fish and Wildlife Service, has confirmed that no species of alligator is known to occur within Guatemala. The American alligator (*Alligator mississippiensis*) and the Chinese alligator (*A. sinensis*) are the only species within the genus *Alligator*. The American alligator is found in the southeastern United States from the Carolinas to Texas. The Chinese alligator is found only in northeastern China.

The alligator prefers fresh water over brackish water, and is found most often in wetland areas. Alligators are generally inactive during the day and can be found basking on creek banks and other areas adjacent to water. Activity increases at night when most feeding takes place. Alligators are carnivorous and consume a wide variety of animals, reptiles, and fish.

When the weather is cold, alligators dig underground dens, and come out during the day to sun themselves. Mating occurs in the spring, after which the females move to dense cover and small isolated ponds to begin nest construction. Females make a large nest-mound for the eggs out of mud and vegetation, and guard the nest during the incubation period. Eggs number from about 20 to 70 and incubate for 65 days. When the young are ready to emerge from the nest, they peep loudly and the female opens the nest and helps release the hatchlings.

Assessment

Neither the American alligator nor the Chinese alligator are known to occur in Guatemala. However, even if the distribution of alligators were to extend into Guatemala, the Guatemala MOSCAMED Program's mitigative procedures that preclude aerial applications of malathion bait spray within 200 meters of any recognized body of water would protect the species.

Commenters who reported the alligator as a species of concern may have meant a caiman or crocodile species. Refer to assessments for those other species in this appendix.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the alligator.

2. Boa constrictor (*Boa constrictor*)

Status

The boa constrictor is a species of concern to Guatemala.

Pertinent Species Information

The boa constrictor is a large, nonvenomous snake that is distributed from Sonora and Tamaulipas south along both coasts of Mexico, and through much of Central and South America to Argentina and Paraguay. The boa constrictor is found throughout Guatemala except for in the Sierra de Chuacus and the Chimaltenangan and Cuilcan areas.

Boa constrictors attain a length of 5 to 6 meters. They inhabit a remarkable range of environments, including wet and dry tropical forests, savannas, very dry thorn scrubs, and cultivated fields. The snakes are crepuscular or nocturnal and seldom bask. Boa constrictors climb well and their young are especially arboreal.

Boa constrictors eat a variety of wild lizards, birds, and mammals as well as poultry and dogs. Individual snakes have been known to eat large animals such as a young deer and ocelot. The snakes choose good sites to ambush their prey, and actively search for good places to sit and wait. Prey is recognized by visual, thermal, and chemical cues. The prey is seized by rapid forward movement of the snake's head, the prey is then constricted, and the animal is swallowed whole.

Boa constrictors give birth to about 20 to 64 live young, each about 0.5 meter long. There is no known parental care. Mating has been reported from August to March and birth from March to August. Sexual maturity occurs when the snake reaches a length of 1.5 to 2 meters.

Assessment

Boa constrictors are one of the top predators in some ecosystems, and seem to do well in the vicinity of humans. The greatest threats to boa constrictors are habitat destruction and removal for the pet trade.

Boa constrictors could conceivably be found within the areas treated by the Guatemala MOSCAMED Program given their widespread distribution in Guatemala. However, agricultural areas are normally subject to much human activity and would not be expected to harbor many boa constrictors. The program use of malathion has not been determined to have an adverse impact upon the species and no adverse effects are expected for the boa constrictor, its habitat, or its prey base as a consequence of the Guatemala MOSCAMED Program.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the boa constrictor.

3. Spectacled caiman (*Caiman crocodilus fuscus*)

Note

The taxonomy of what may be termed the '*Caiman crocodilus* complex' is uncertain and subject to interpretation. Taxa recognized by some authorities are not recognized by others. Although the taxonomy for members of this species awaits better resolution, this assessment will address the subspecies that occurs in Guatemala, currently termed *Caiman crocodilus fuscus*.

Status

This taxon is of special concern to Guatemala.

Pertinent Species Information

This subspecies of spectacled caiman extends from southern Mexico (Isthmus of Tehuantepec) and Nicaragua south through Central America to the Pacific slopes of Ecuador, Colombia, and northwest Venezuela. In Guatemala, this crocodile is found in the Escuintlan Region along the Pacific coast.

Caimans belong to the alligator family and strongly resemble alligators in outward appearance, but only reach a maximum size of 1 to 2 meters. Spectacled caimans are so called because a curved ridge of bone that connects the eye sockets is thought to resemble the nose bow of a pair of spectacles.

Caimans prefer the quiet waters of lakes, ponds, swamps and marshes, sometimes in brackish waters, or along the bends and meandering tributaries where the currents are slight. Individuals tend to submerge during the hottest part of the day and move onto shore during the evening hours. During the dry season, caimans bury themselves in the mud of shallow pools and in leaf litter in shaded parts of the forest. Adult caimans are opportunistic feeders taking whatever they can kill. Snails, crustaceans, and fish are preferred food items.

Breeding of spectacled caimans usually takes place from January to March. The female constructs a nest mound from organic debris, and deposits 15 to 30 eggs which incubate for 75 to 80 days. A well-developed pattern of maternal care has been reported.

Assessment

The mitigative procedures established by the Guatemala MOSCAMED Program specify that no aerial applications of malathion bait spray will be made within 200 meters of any recognized body of water. Potential for runoff of pesticide is averted by suspension of treatments during the rainy season. Spectacled caimans live either in or at the edge of the water and therefore their habitat will not be subject to program treatments. The spectacled caimans themselves, their habitat, and their prey base not expected to be affected by Guatemala MOSCAMED Program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the spectacled caiman.

4. Loggerhead sea turtle (*Caretta caretta*)

Status

The loggerhead sea turtle was federally listed as a threatened species in 43 FR 32808 (July 28, 1978).

Pertinent Species Information

The loggerhead turtle is widely distributed throughout the world's temperate and subtropical oceans, with Atlantic, Mediterranean, and Pacific populations. Loggerhead sea turtles have been recorded from the Caribbean waters of Guatemala, but not from the Pacific waters.

The loggerhead is a large sea turtle that can weigh over 220 kilograms with a total carapace length of 144 centimeters at maturity. The broad, scaly head is yellowish to olive-brown and the carapace is reddish-brown. Limbs are modified as flippers.

The majority of the loggerhead life cycle is spent in the open waters of the ocean. This pelagic, or open water, life stage lasts for several years, but the exact time it takes for loggerhead sea turtles to grow and reach sexual maturity in the open ocean waters is unknown. During their life in the ocean loggerheads are carnivorous and feed mostly on ocean-dwelling organisms such as mollusks, sponges, and horseshoe crabs.

The brief, terrestrial life stage begins when female loggerheads migrate from the open ocean waters and appear on nesting beaches. Mature females return to the same "home" beaches at intervals of two to three years. Adult females lay an average of 2 clutches of eggs per season at approximately 13-day intervals. The eggs incubate on the nesting beaches for two months. The hatchlings emerge from the nest as a group, usually at night, and quickly make their way to the water and eventually the open ocean.

Assessment

Loggerhead sea turtles have only a brief contact with land during their life cycle. The beaches in Guatemala that could be used for nesting by loggerhead turtles do not contain Medfly hosts and are not part of the treatment areas.

The open ocean waters that loggerhead turtles inhabit for the majority of their life cycle are far removed from the treatment areas. The turtles themselves, their habitats, and the food they consume, would not be expected to come into contact with any Guatemala MOSCAMED Program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the loggerhead sea turtle.

5. Green sea turtle (*Chelonia mydas*)

Status

The green sea turtle was federally listed as a threatened species, except in Florida and the Pacific coast of Mexico where it is federally listed as an endangered species in 35 FR 16047 (October 13, 1970) and in 43 FR 32808 (July 28, 1978).

Pertinent Species Information

Green turtle nesting beaches are widely distributed along the tropical and subtropical coasts of the Atlantic Ocean, reaching from Cape Canaveral, Florida, in the north to as far south as French Guiana. Mature turtles of the eastern stock appear to migrate within the area that includes the southeastern U.S. coast, Ascension Island, and northern Brazil. Green sea turtles have been reported from Guatemala's Caribbean waters, but not from its Pacific waters.

This long-lived species attains an average weight of 205 kilograms and has an average carapace length of 122 centimeters. Adult shell coloring varies from light to dark olive-brown. The head of adults appears small in comparison to body size. The front paddle-shaped flippers are strongly developed and contain a single claw.

The adult green sea turtle spends most of its life in open ocean waters. Green sea turtles have the unique ability among marine turtles to digest plant material and spend most of their adult life grazing in offshore beds of sea grasses.

The brief, terrestrial life stage begins when mature green sea turtles return to their nesting beaches. Nest site specificity may be attributed to natal beach imprinting, may be learned coincidentally with subadult migrations, or may be a result of nesting migrations with experienced adults already familiar with a specific beach. Adult females lay an average of 100 to 200 eggs. Incubation is temperature dependent and lasts from 48 to 70 days. Hatchlings swarm to the water and are soon dispersed at sea.

Assessment

Green sea turtles have only a brief contact with land during their life cycle. The beaches of Guatemala that could be used for nesting by green sea turtles do not contain Medfly hosts and are not part of the treatment areas.

The open ocean waters that green turtles inhabit for the majority of their life cycle are far removed from the treatment areas. The turtles themselves, their habitat, and the food they consume, would not be expected to come into contact with the Guatemala MOSCAMED Program.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the green sea turtle.

6. American crocodile (*Crocodylus acutus*)

Status

The American crocodile was federally listed as an endangered species in 40 FR 44151 (September 25, 1975) and in 44 FR 75076 (December 18, 1979).

Pertinent species information

The American crocodile is currently found in coastal wetlands along the Pacific Ocean from western Mexico south to Ecuador, and along the Atlantic Ocean from Guatemala north to the extreme southern tip of Florida. In Guatemala, the American crocodile occurs in the Peten Region along the Caribbean Sea, and the Escuintlan Region along the Pacific coast.

The American crocodile grows from approximately 26 centimeters at hatching to an average overall length of 3.6 meters. This crocodile is similar in appearance to an alligator, except the triangular head of the crocodile ends in a more pointed snout. This species appears shy, and is not often seen in close proximity to human dwellings.

American crocodiles are most commonly found in tropical wetlands and along stream banks. Crocodiles are generally inactive during the day, remaining on secluded creek banks, in dens, or hidden in thickets at the edge of the water. Activity increases at night when crocodiles move into creeks and other nearby bodies of water to feed. The American crocodile is carnivorous. Adults feed on fish, crabs, birds, and turtles. Juveniles have been observed feeding on small fish and arthropods.

Reproduction is in the spring, with eggs laid in late April or early May. Crocodiles often construct low nest mounds for egg deposition in sand, marl, or peat soils that are at the heads of small beaches or along creek banks. While the female crocodile does not defend the nest, she does open the nest to release the young after hatching, usually in July or August.

Assessment

The American crocodile is not expected to be affected by the Guatemala MOSCAMED Program because of its reclusive nature and its remote habitat (away from agricultural areas). It is also afforded much protection by the Guatemala MOSCAMED Program's established mitigative procedures that preclude aerial applications of malathion bait spray within 200 meters of any recognized body of water. Potential for runoff of pesticide is averted by suspension of treatments during the rainy season. Neither the American crocodile nor its prey base will be affected by program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the American crocodile.

7. Morelet's crocodile (*Crocodylus moreletii*)

Status

The Morelet's crocodile was federally listed as an endangered species in 35 FR 8495 (June 2, 1970).

Pertinent Species Information

The Morelet's crocodile is distributed from central (possibly northern) Tamaulipas through the other Atlantic states of Mexico to the Yucatan Peninsula, and southward through Belize and Guatemala. In Guatemala, this species is found in aquatic environments from the northern regions to nearly the Motagua River valley. This species may also occur in northern Honduras.

The Morelet's crocodile is closely related to the true crocodiles in the Americas. Morelet's crocodiles are small, averaging an adult length of 2 meters, with some individuals up to 3 meters long.

The typical habitat for Morelet's crocodiles is in quiet and shallow freshwater swamps, backwaters, vegetation-choked streams, ponds and lagoons with floating vegetation and densely vegetated banks, or within forested areas. Such areas subject to annual flooding also may have a dry season during which the crocodiles burrow into muddy banks or under tree roots. Individuals have also been seen foraging in rapids and in rivers. The principal food items are fish, small mammals, and crustaceans.

Morelet's crocodiles can reproduce while still fairly young, at about 5 years of age. The female will tear up grass and plants within a radius of about 5 meters and form a mound up to 3 meters in diameter by about 1 meter high. Most nests are located on land within a few meters of water, but some nests are built in the water over an accumulation of aquatic plant material. The incubation period for the eggs is about 80 days. The nesting female remains near the nest, responds to the grunting vocalization of hatchlings, and releases them from their eggs and carries them to water.

Assessment

The Morelet's crocodile is not expected to be affected by the Guatemala MOSCAMED Program because of the nature of its habitat (containing no Medfly host crops, and thus not subject to treatment). It is also afforded much protection by the Guatemala MOSCAMED Program's established mitigative procedures which preclude aerial applications of malathion bait spray within 200 meters of any recognized body of water. Potential for runoff of pesticide is averted by suspension of treatments during the rainy season. Neither the Morelet's crocodile nor its prey base will be affected by program activities.

Conclusion

The Guatemala MOSCAMED program will have no effect on the Morelet's crocodile.

8. Central American river turtle (*Dermatemys mawii*)

Status

The Central American river turtle was federally listed as an Endangered Species in 48 FR 28464 (June 22, 1983).

Pertinent Species Information

This large river turtle is found only in the coastal lowlands of southern Mexico, Guatemala, and Belize. Its distribution within Guatemala is restricted to the Peten, the northernmost region of the country bordering Mexico. The turtle is hunted extensively for food and has been seriously depleted throughout its range.

The Central American river turtle can weigh 22 kilograms and have a total carapace length of over 60 centimeters. The shell is large and heavy with a row of small plates on the bridge between the carapace and plastron.

A highly aquatic web-footed species, the turtle is awkward on land and does not climb out on logs or river banks to bask, but occasionally floats passively at the surface of quiet waters. The Central American river turtle inhabits large open rivers and permanent lakes, prefers clean water, and is seldom found in seasonal or temporary ponds, although it will tolerate brackish water.

This species is primarily nocturnal, becoming active around twilight. During the day this turtle floats or hides on the bottom. Juveniles hide in vegetation in shallow water. Individuals can maintain activity underwater for long periods of time without rising to breathe air. The Central American river turtle is entirely herbivorous, feeding on aquatic vegetation or leaves and fruit that have fallen into the water.

High water during the rainy season may help females move up into shallow side channels where nesting occurs. Nests may be made in sand, clay, or mud, and are excavated at the very margin of the water or only a few feet from it.

Assessment

The mitigative procedures associated with the MOSCAMED Program specify that no aerial applications of malathion bait spray will be made within 200 meters of any recognized body of water. Potential for runoff of pesticide is averted by suspension of treatments during the rainy season. The Central American river turtle lives either in or at the edge of the water and its habitat will not be within any treatment area. The turtles themselves, their habitat, and their plant food sources are expected to remain unaffected by Guatemala MOSCAMED Program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the Central American river turtle.

9. Leatherback sea turtle (*Dermochelys coriacea*)

Status

The leatherback sea turtle was federally listed as an endangered species in 35 FR 8495 (June 2, 1970).

Pertinent Species Information

Leatherback sea turtles are widely distributed in the world's oceans, but probably never have been numerous. For Guatemala, leatherback sea turtles have been reported from only the Pacific Ocean waters, but it is probable that those turtles are present in Guatemala's Caribbean waters also.

The leatherback sea turtle is the largest sea turtle in the world with an average weight around 365 kilograms and carapace length of 1.5 meters at maturity. While all other sea turtles have bony-plated carapaces, the leatherback carapace has a rubbery texture. Limbs are modified as flippers and lack claws.

The majority of the leatherback sea turtle life cycle is spent in the open waters of the ocean. Its life history is poorly documented because juvenile turtles have rarely been observed. The diet of leatherbacks during their years of life in the ocean consists primarily of soft-bodied animals such as jellyfish, although small fish and crustaceans are also consumed.

The brief, terrestrial life stage begins when female leatherbacks move from the open ocean waters onto nesting beaches. The leatherbacks normally nest in alternate years. Renesting occurs about every 10 days and commonly occurs 6 or 7 times a year. Adult females spend about 2 hours laying an average of 35 eggs, plus 30 smaller yolkless eggs in a nest. The eggs incubate on nesting beaches for about two months. Hatchlings dig out of the sand as a group and head to sea as quickly as they can to begin the open ocean portion of their life cycle.

Assessment

Leatherback sea turtles have only a brief contact with land during their life cycle. The beaches in Guatemala that could be used for nesting by leatherback turtles do not contain Medfly hosts and are not part of the treatment areas.

The open ocean waters that leatherback turtles inhabit for the majority of their life cycle are far removed from the treatment areas. The turtles themselves, their habitats, and the food they consume, would not be expected to come into contact with any Guatemala MOSCAMED Program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the leatherback sea turtle.

10. Hawksbill sea turtle (*Eretmochelys imbricata*)

Status

The hawksbill sea turtle was federally listed as an endangered species in 35 FR 8495 (June 2, 1970).

Pertinent Species Information

The hawksbill turtle is found mainly in tropical seas throughout the world, and is separated into two distinct subspecies—Atlantic and Indo-Pacific. The hawksbill sea turtle is found in Guatemalan waters of both the Pacific Ocean and Caribbean Sea.

The hawksbill turtle is one of the smaller sea turtles with a weight of about 45 kilograms (100 lbs) and an average carapace length of 60 centimeters at maturity. The name "hawksbill" refers to this turtle's prominent hooked beak.

The majority of the hawksbill sea turtle life cycle is spent in the open ocean waters. This pelagic, or open water, life stage lasts for several years. During this stage of their life, hawksbills feed near coral reefs on jellyfish, sponges, and plant material.

The brief terrestrial portion of the life cycle begins when female hawksbills move from the ocean onto nesting beaches. Females may clamber over reefs, rocks, or rubble to nest among the roots of trees and bushes on the chosen beach. About 160 eggs are deposited in a nest. The eggs incubate for about 50 days. Hatchlings dig out of the nest as a group, head to the ocean as quickly as they can, and then disperse into the open waters.

Assessment

Hawksbill sea turtles have only a brief contact with land during their life cycle. The beaches in Guatemala that could be used for nesting by hawksbill turtles do not contain Medfly hosts and are not part of the treatment areas.

The open ocean waters that hawksbill turtles inhabit for the majority of their life cycle are far removed from the treatment areas. The turtles themselves, their habitats, and the food they consume, would not be expected to come into contact with any Guatemala MOSCAMED Program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the hawksbill sea turtle.

11. Mexican beaded lizard (*Heloderma horridum*)

Status

The Mexican beaded lizard is a species of concern to Guatemala.

Pertinent Species Information

The Mexican beaded lizard is distributed from latitude 25 in central and western Mexico, southward to northern Central America. In Guatemala, the Mexican beaded lizard is found at elevations ranging from 300 to 600 meters within the upper and middle Motagua Valley and tributaries, the upper tributaries of the Rio Grijalva in western Guatemala, and the Jalapan Region.

The Mexican beaded lizard is a heavy-bodied lizard, similar to the gila monster. These two lizards are the only members of the Helodermatidae which are the only known venomous lizards.

Mexican beaded lizards are short-tailed, clumsy looking lizards that are gaudily marked with dark reticulations on a yellow or orange background. These lizards have a large, blunt head with small, beady eyes. The body is elongate, covered with scales, and has short legs ending in powerful digits equipped with remarkably strong claws. Adults may reach an overall length of 900 millimeters.

Mexican beaded lizards are residents of arid areas and must withstand long periods of time without water. Ordinarily the slow moving Mexican beaded lizard moves about only during the rainy season. These lizards remain buried in underground burrows during periods of prolonged droughts, and withstand long periods of time when food is not available. Most movements outside their burrows are at night and are associated with searches for food. The lizards do not rely on quick movement to catch their prey. Instead they merely walk up to and capture their prey, which consists primarily of animals that cannot run such as nestling birds, small animals, and the eggs of birds and reptiles.

Approximately 3 to 7 eggs are buried about 125 millimeters deep in sand. The nest areas are usually located in an open place that is exposed to the sun but usually near a stream or dry wash. The eggs are thin-shelled, and incubate for 28 to 30 days.

Assessment

Guatemala MOSCAMED Program activities are not projected for the arid regions inhabited by the Mexican beaded lizard. Also, the lizards are active only during the rainy season when treatments are not conducted. Because of the remoteness of their habitat, it is also unlikely that the prey base of Mexican beaded lizards will be affected.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the Mexican beaded lizard.

12. Green iguana (*Iguana iguana*)

Note

This species was formerly named *Iguana iguana rhinolopha.*

Status

The green iguana is a species of concern to Guatemala.

Pertinent Species Information

This species is found on the mainland of the North American continent from northern Mexico southward, excluding the Yucatan Peninsula, through Central America and South America to at least the Tropic of Capricorn in Paraguay and southeastern Brazil. It is found throughout Guatemala, except for the upper Rio Chixoy and associated Salama Basin, the upper tributaries of the Rio Grijalva in western Guatemala, the Sierra de las Minas, the Sierra de Chuacus, and the entire Huehuetenangan Region.

Green iguanas are the largest and most conspicuous lizards in Central America with adult lengths exceeding 2 meters. These lizards are heavy-bodied, and have scaly bodies, four well- developed limbs, and a tail that is longer than the body. The flesh of iguanas is a very common food source for humans, especially in rural communities. Adult iguanas spend most of their time basking in trees, although they are occasionally observed basking on the ground, especially in areas little frequented by humans. The green iguana is a tree dweller that lives chiefly on a diet of vegetation, including leaves of trees and vines. Reproduction is in the middle of the dry season (January and February), and eggs hatch near the onset of the rainy season in April.

Assessment

In Guatemala, overhunting, destruction of habitat, and agricultural practices have all contributed to the drastic decline of iguana populations. In the sparsely populated Caribbean lowlands the animals have been little affected, but in the heavily cultivated Pacific lowlands the populations of green iguanas are mere remnants of former populations. On the Pacific lowlands the best iguana habitat was in the coastal mangrove forests, but cutting has reduced these forests to about 7 percent of their original areas.

The MOSCAMED program will not treat the Pacific mangrove forests that have been the prime habitat of the green iguana. Also, mitigative procedures associated with the MOSCAMED Program will further protect green iguanas by alternate strip spraying, prohibiting aerial applications of malathion bait spray within 200 meters of any recognized body of water, and suspending treatments during the rainy season. Even if isolated green iguanas should come in contact with MOSCAMED program activities, those scattered individuals are not likely to affected by the low amounts of malathion that will be applied. The food source of the green iguana will not be affected by the MOSCAMED program.

Conclusion

The Guatemala MOSCAMED Program will have no effect on green iguanas.

13. Kemp's ridley sea turtle (*Lepidochelys kempii*)

Status

The Kemp's ridley sea turtle was federally listed as an endangered species in 35 FR 18320 (December 2, 1970).

Pertinent Species Information

The Kemp's ridley sea turtle is found primarily throughout the Gulf of Mexico. It is well known from the waters off of the Yucatan Peninsula, and a few recorded sightings have been made in the Caribbean south of Guatemala. The presence of this turtle in Guatemalan waters has not been confirmed, however.

The Kemp's ridley sea turtle is a relatively small sea turtle that has an average weight of about 41 kilograms and an average carapace length of 90 centimeters. The oval carapace is a dark, mottled green. The forelimbs are modified as flippers.

The majority of the species' life cycle is spent in the open waters of the ocean. This pelagic, or open water, life stage lasts for several years, but during this stage the turtles disperse so widely that scientists loose track of the turtles location. This phase is often referred to as "the lost years." Kemp's ridley sea turtles are primarily carnivorous and feed mostly on blue crabs.

Mature female Kemp's ridley sea turtles return to nest on the beaches where they were born and the terrestrial stage of the life cycle begins. Nests of this species are almost entirely restricted to the beach near Rancho Nuevo in the Mexican state of Tamaulipas, and have been observed only rarely on other Caribbean beaches. Individual females return to nesting beaches every 2 to 8 years, and deposit from 80 to 200 eggs in nests scooped out of the sand. The eggs hatch in about two months and the hatchlings quickly move to the sea to begin their open ocean life stage.

Assessment

The Kemp's ridley sea turtle has not been documented in Guatemalan waters, and even if it were to occur there, its brief contact with land during its life cycle would not place it at risk from Guatemala MOSCAMED Program activities. It is highly unlikely that the turtles, their habitat, or the food they consume, would have any contact with the MOSCAMED Program.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the Kemp's ridley sea turtle.

14. Olive ridley sea turtle (*Lepidochelys olivacea*)

Status

The olive ridley sea turtle was federally listed as a threatened species, with endangered species status for Mexico, in 43 FR 32808 (July 28, 1978).

Pertinent Species Information

The olive ridley turtle is widely distributed throughout tropical coastal waters of the Pacific, Indian, and South Atlantic Oceans. The olive ridley sea turtle is known to nest on shores and inhabit the waters of the Pacific coast of Guatemala, but has not been observed in the Caribbean waters or shores of Guatemala.

The olive ridley sea turtle is a long-lived turtle that weighs an average of 41 kilograms and has a average carapace length of about 90 centimeters. The oval shell is a mottled, olive green. Forelimbs are modified as flippers.

The majority of the olive ridley sea turtle's life cycle is spent in the open waters of the ocean. During this life stage the turtles feed on crabs, other crustaceans, and mollusks. This pelagic, or open water, life stage lasts for 2 to 8 years before tens of thousands of mature olive ridley sea turtles begin to aggregate.

The brief, terrestrial life stage begins when mass numbers of females come ashore simultaneously to nest. Females deposit from 80 to 200 eggs in nests scooped out of the sand. The eggs incubate for about 50 days and typically over 75 percent of the eggs fail to hatch. The hatchlings quickly move from the beach to the ocean waters.

Assessment

Olive ridley sea turtles have only a brief contact with land during their life cycle. The beaches of Guatemala that could be used for nesting by olive ridleys do not contain Medfly hosts and are not part of the treatment areas.

The open ocean waters that olive ridley turtles inhabit for the majority of their life cycle are far removed from the treatment areas. The turtles themselves, their habitat, and the food they consume, would not be expected to come into contact with Guatemala MOSCAMED Program activities.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the olive ridley sea turtle.

D. Endangered and Threatened Amphibian of Guatemala

1. Toad (*Bufo spp.*)

Status

The toad is considered a genus of concern by Guatemala.

Pertinent Species Information

At least nine species of the genus *Bufo* are found in Guatemala. Some species are distributed throughout the country, while other species are restricted to a single area. For example, *B. valliceps* occurs throughout every region in Guatemala while *B. tacanensis* is found only in the Fuegan Region, which has an elevation of 1,500-1,700 meters.

Typical toads of the genus *Bufo* are chunky, short-legged, and warty, and have parotoid glands that distinguish them from all other tailless amphibians. The parotoids and warts secrete a caustic, sticky white substance that is poisonous to some animals. Many animals, however, eat toads with no ill effect. Adult toads are carnivorous, feeding primarily on insects and other invertebrates.

Bufo species differ in size, shape of the parotoids, conspicuousness and arrangement of the cranial crests (ridges that frame the inner side of the upper eyelids), warty appearance of the foot tubercles, and color. Color may change from light to dark in response to temperature. Adult males of most species have a dark throat.

Breeding occurs usually after rainfalls during the spring and summer, when the chorus of the males attracts the females to the breeding pond. Eggs are laid in long strings. Tadpoles emerge from the eggs and develop into miniature toads within a few weeks. These small toads then swarm onto the bank of the pond and migrate toward drier land. Toads are able to live on land instead of in or near water because their heavy, dry skins prevent the evaporation of water.

Assessment

The mitigative procedures associated with the MOSCAMED Program specify that no aerial applications of malathion bait spray will be made within 200 meters of any recognized body of water. Therefore, the eggs and tadpoles of Guatemalan toads will not be affected by Guatemala MOSCAMED Program activities.

The Guatemala MOSCAMED Program treatments have not been shown to have a direct adverse effect upon toads. Some insects that constitute the prey base of Guatemalan toads might be affected, but would be expected to recover quickly because of the selective nature of program treatments (alternate strip applications and treatments only of Medfly host produce).

Conclusion

The Guatemala MOSCAMED Program will have no effect on the toad.

E. Endangered and Threatened Insect of Guatemala

1. Coral-fronted threadtail (*Neoneura aaroni* Calvert)

Status

The species *Noeneura aaroni* was identified as an unnamed fly species of concern to Guatemala in a list provided to the Fish and Wildlife Service by the International Union on the Conservation of Nature and Natural Resources (IUCN). The listing apparently refers to *Neoneura aaroni* Calvert, the coral-fronted threadtail.

Pertinent Species Information

The coral-fronted threadtail is a species of damselfly which does not occur in Guatemala. It is distributed from southern Texas (Caldwell, Goliad, Gonzales, Medina, Nueces, San Patricio, and Victoria counties) into northern Mexico. The limit of its southern range is not known, but is north of Mexico City.

The larvae of the coral-fronted threadtail are reported to inhabit deep small streams or small clean rivers with slow moderate flow, favoring shaded areas. Little is known about the life cycle of the species, but the larvae are thought to be general predators like other *Neoneura*. The distance adults range from their larval aquatic habitats is not known. Like all Odonata, the coral-fronted threadtails take only live food.

Two other species of *Neoneura* occur in Guatemala. Both species, *N. paya* and *N. amelia*, are fairly common.

Assessment

The coral-fronted threadtail is not known to occur in Guatemala. Therefore the species, its habitat, and its prey species are not expected to be affected by the Guatemala MOSCAMED Program.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the coral-fronted threadtail.

F. Endangered and Threatened Plants of Guatemala

1. Guatemalan fir (*Abies guatemalensis*)

Status

The Guatemalan fir was federally listed as a threatened species in 44 FR 65005 (November 8, 1979).

Pertinent species information

The Guatemalan fir is a conifer which occurs at higher elevations in the mountains of Guatemala, Mexico, Honduras, and El Salvador. It can be found from western Guatemala to Cerro Santa Barbara, Honduras and east of La Palma, El Salvador. In Guatemala, the Guatemalan fir is found usually at elevations of 2,700 to 3,500 meters but has been reported at elevations of up to 4,000 meters. The species occurs also in the States of Jalisco, Guerrero, Oaxaca, and Chiapas in Mexico. In Mexico, it rarely occurs at elevations of less than 1,800 meters.

The Guatemalan fir is a conical tree, 20 to 35 meters tall and 60 to 90 centimeters in girth, that has horizontal branches. Its bark is blackish-brown and is divided into plates. Branchlets are reddish-brown to deep blackish-red. The species' female cones are oblong and cylindrical, and are 8 to 11.5 centimeters long and 4 to 5.5 centimeters wide.

The preferred habitat for the Guatemalan fir is moist or wet temperate forests of the high mountains. The Guatemalan fir is wind-pollinated. In Guatemala, this species produces cones only infrequently, perhaps because it is at the limit of its geographical and evolutionary range. The poor reproduction which characterizes the species in its native habitat hinders population regeneration following exploitation by cutting or clearing.

Assessment

The decline of the Guatemalan fir and reduction of its former range has been attributed to habitat destruction and overharvesting of the species. Much of the Guatemalan fir's habitat has been burned and cleared to convert it to farming land or grazing land for sheep and other livestock that subsequently feed on or otherwise destroy the species' new seedlings. The species has been overharvested for its wood value and decorative purposes. Guatemalan fir saplings are highly prized as Christmas trees by the residents of Guatemala City, and its branches have been used abundantly in church decorations since at least the early 19th century. The destruction of seedlings of the Guatemalan fir by sheep and other livestock, along with the removal of saplings for Christmas trees, have nearly eliminated all regeneration of this tree in Guatemala.

The Guatemala MOSCAMED Program is not expected to affect the Guatemalan fir because the species' habitat (high elevations in the mountains of Guatemala) does not coincide with program areas. Even if the habitat did coincide with program treatment areas, no effect on the species would be expected since the insecticide used has no direct phytotoxic effect and the species does not require insect pollinators for reproduction.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the Guatemalan fir.

2. Flower of San Sebastian (flor de San Sebastian) or guaria morada (*Cattleya skinneri*)

Status

The flower of San Sebastian is a species of concern to Guatemala.

Pertinent Species Information

Cattleya skinneri is an orchid that is widely found in Guatemala. The national flower of Costa Rica, *C. skinneri* occurs at elevations up to 1,250 meters, as an epiphyte on terrestrial granite banks and on trees in humid forests. It is also known as the candlemas (candelaria).

Information concerning the species' blooming period in Guatemala was not forthcoming from a literature search and was unavailable from orchid specialists contacted. Other *Cattleya* spp. orchids are pollinated by bees (euglossine, melopine, and carpenter bees).

Assessment

The *Cattleya* genus of orchids has widespread distribution in Guatemala and other parts of Central America. Members of its species, including *C. skinneri*, are commercially cultivated.

The Guatemala MOSCAMED Program is not expected to affect *C. skinneri* because of the lack of a direct effect of the program treatments on the species and the lack of a significant effect on the species' potential insect pollinators. Although insects could be affected by program insecticides, the bee populations which pollinate this species of orchid are not expected to be adversely impacted because they are not attracted to the bait used in the formulation and because the strip method of application leaves much area untreated and unaffected.

Conclusion

The Guatemala MOSCAMED Program will not effect the flower of San Sebastian.

3. Orchid species (*Eriopsis biloba*)

Status

Eriopsis biloba is a species of concern to Guatemala

Pertinent Species Information

The orchid species *Eriopsis biloba* is not listed in catalogues of Guatemalan flora and is generally not considered a species of Guatemala. However, recent reports have claimed that the species has been discovered in forests bordering coffee plantations in the Polochic River area of Guatemala. Sparse data is available concerning the geographic distribution of the species; however it generally is found at elevations greater than 1,200 meters.

An extensive literature search failed to find any information or data relative to pollinators of *E. biloba* and no information on pollination has been found for any member of this genus.

Assessment

If *Eriopsis biloba* does exist in Guatemala, it probably occurs only in localized forest areas of the Polochic River area. These forest areas would not be subject to treatments of the Guatemala MOSCAMED Program.

Although there is little, if any, information available on the pollination biology of this species, concerns about potential environmental effects of the program on this species would probably relate to protection of potential pollinators. The Guatemala MOSCAMED program's procedures and mitigative measures are designed to minimize environmental effects on beneficial species such as potential pollinators. Bee populations which might pollinate this species of orchid are not expected to be adversely impacted because they are not attracted to the bait used in the formulation and because the strip method of application leaves much area untreated and unaffected.

Conclusion

The Guatemala MOSCAMED Program will not effect the orchid *Eriopsis biloba.*

4. Orchid species (*Lycaste dowiana*)

Status

Lycaste dowiana is a species of concern to Guatemala.

Pertinent Species Information

Published records of distribution data for *L. dowiana* list Costa Rica as the northernmost limit for the distribution of this species. However, recent reports have claimed that the species has been discovered in forests bordering coffee plantations in the Polochic River area of Guatemala. In Costa Rica, the species is uncommon but widely distributed, found in the Atlantic coastal rain forest. Its habitat is characterized by warm, temperate, and humid conditions, and the absence of any dry season.

The published records which describe pollinators of *Lycaste* spp. list only euglossine bees.

Assessment

If *Lycaste dowiana* does exist in Guatemala, it probably occurs only in localized forest areas of the Polochic River area. These forest areas would not be subject to treatments of the Guatemala MOSCAMED Program.

Concerns about potential environmental effects of the program on this species would probably relate to protection of potential pollinators. The only recorded pollinators for members of the genus *Lycaste* are euglossine bees, which are closely related to bumble bees and honey bees. The Guatemala MOSCAMED program's procedures and mitigative measures are designed to minimize environmental effects on beneficial species such as potential pollinators. The Guatemala MOSCAMED Program will have no significant impact on euglossine bees because the strip method of application leaves much area untreated and unaffected.

Conclusion

The Guatemala MOSCAMED Program will not effect the orchid *Lycaste dowiana*.

5. White nun (or monja blanca) orchid (*Lycaste skinneri*)

Note

This species is considered taxonomically synonymous with *Lycaste virginalis* var. *alba*.

Status

The white nun orchid is a species of concern for Guatemala.

Pertinent Species Information

The white nun orchid is the national flower of Guatemala. It occurs as an epiphyte on trees in the upper montane cloud forests at elevations up to 1,800 meters or more. According to Guatemalan historical records, only an estimated 200 plants remain in the wild, found in the Coban Region. The species has been designated as in imminent danger of extinction by the International Union for Conservation of Nature and Natural Resources.

The white nun orchid is usually found about 7 meters above ground level on heavily moss-laden trees of 10-20 centimeters in diameter.

All published records describing pollinators of *Lycastes spp. list only euglossine bees.*

Assessment

All known individuals of this species remaining in the wild are believed to be in the Coban Region of Guatemala, which is well out of the Guatemala MOSCAMED Program area. The Guatemala MOSCAMED Program is not expected to affect this species or any of its pollinators, either directly or indirectly.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the white nun orchid.

6. Guatemalan magnolia (*Magnolia guatemalensis*)

Status

The Guatemalan magnolia is considered a species of concern to Guatemala.

Pertinent species information

The only known locality for the Guatemalan magnolia is in the great swamp east of Tactic, Alta Verapaz, Guatemala (Standley and Steyermark, 1946). There the species is abundant, forming dense groves or thickets.

The Guatemalan magnolia can be recognized by its leaves which have a distinctive concave shape with in-curved sides, and by its stipules and sepals which frequently are bright red. The tree may attain a height of 15 meters at maturity.

The significance of certain beetles in the pollination of magnolias has been known for well over 100 years. Rove beetles (Staphylinidae), tumbling flower beetles (Mordellidae), and sap beetles (Nitidulidae) are the more common pollinators for magnolias native to the United States (Thien, 1974).

Assessment

The Guatemalan magnolia is known only from a swamp locality east of Tactic, Guatemala. This region of Guatemala, near the city of Coban, is not part of the Guatemala MOSCAMED Program area. Because it is far from the program area, the Guatemalan orchid, its habitat, and its potential pollinators are not expected to be affected by the Guatemala MOSCAMED Program.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the Guatemalan magnolia.

7. Orchid species (*Phragmipedium caudatum*)

Note

This species is considered taxonomically synonymous with *Lycastes warscewiczianum*.

Status

Phragmipedium caudatum is a species of concern for Guatemala.

Pertinent Species Information

Phragmipedium caudatum, one of the New World tropical lady slipper orchids, occurs from Guatemala to Peru. In Guatemala, the species is found on rocky cliffs in mountainous regions at elevations of 2,000 to 3,000 meters. Old Guatemalan historical records of its geographical distribution record that this species has been found in the following areas: Alta Verapaz (Pansamala), Xuchaneb, Huehuetenago (about 17 miles north of Barillas in the vicinity of Maxbal), and Guatemala (S.S.E. of Coban between San Agustin A. and Salama).

P. caudatum is a large and showy orchid with petals that may grow up to a meter in length. The distribution of *P. caudatum* extends southward to Peru where it is fall blooming plant, although an occasional spring bloom may occur. Insect pollination of a closely related orchid, *P. longifolium* var. *hartwegii*, is attributable to syrphid flies and euglossine bees.

Assessment

The Guatemala MOSCAMED Program is not expected to affect the *Phragmipedium caudatum* because the specific habitat of the species does not coincide with program treatment areas or other agricultural areas where treatments will be necessary. Accordingly, there would be no direct effect on the species itself or significant indirect effect on the insect pollinators of the species.

This orchid is further removed from program treatment areas because Medfly hosts generally occur at or below 2,000 m in elevation. Cooler temperatures at this elevation also make this species' habitat unsuitable for the Medfly.

Conclusion

The Guatemala MOSCAMED Program will have no effect on the *Phragmipedium caudatum* orchid.

* U.S. G.P.O.:1991-281-088:40047/APHIS

RECORD OF DECISION

GUATEMALA MOSCAMED PROGRAM

I have reviewed the Animal and Plant Health Inspection Service (APHIS) Environmental Analysis and associated Economic Analysis for the Guatemala MOSCAMED Program. The Environmental Analysis considered the following program alternatives: (1) no action, (2) Isthmus of Tehuantepec stable barrier zone, and (3) eradication of Mediterranean fruit fly (Medfly) from Guatemala. The analysis also considered the following control alternatives: (1) no action, (2) sterile insect technique, (3) chemical control, (4) cultural control, (5) regulatory control, (6) integrated control.

The Environmental Analysis analyzed those alternatives with respect to program efficacy and potential environmental consequences. Program operational procedures and mitigative measures were considered also with respect to their ability to minimize environmental consequences. I have concluded that adherence to the operational procedures, mitigative measures, and environmental safeguards discussed in the analysis will result in no significant adverse impacts to the human environment. No significant primary or secondary effects and no significant cumulative effects (direct or indirect) are expected as a consequence of the program.

APHIS selects eradication of Medfly from Guatemala using the control alternative of integrated control as the preferred alternative. For this program, integrated control would afford the combination of maximum environmental protection with program efficiency. Failure to implement cooperative efforts to eradicate Medfly within Guatemala would result in a slow expansion of the infested territory and diminished quality and quantity of host produce.

This Environmental Analysis satisfies both the requirements of the Senate Agricultural Appropriations Committee Report of 1988 and the requirements of Executive Order 12114. Accordingly, this Environmental Assessment provides the basis for APHIS participation in a cooperative international Medfly eradication program in Guatemala.

Robert Melland

for: James W. Glosser, Administrator
Animal and Plant Health Inspection Service

5/21/91
Date